ENGINEERING ENGLISH

BY

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INTRODUCTION

"'Engineering English!'—and how might that differ," some one exclaims, "from any English?" A fair question, and one deserving a serious answer.

Prose we have and poetry,—De Quincey's "literature of knowledge" and "literature of power,"—the latter art, the former science; the one impressionistic and imaginative, and the other factual, sharply focused, practical, and expository. The one in its growth and development is free and organic; the other in its habitual procedure is frankly mechanical and all but stereotyped. The end in one case is pleasure, in the other serious instruction; and the means adopted to secure these ends are no less diverse than the ends themselves. Different they are in vocabulary, distinct in their use of figures and abbreviations, widely separated in their *genres,* and of marked divergence in their criteria of excellence. The story writer, the dramatist, the essayist, these speak one language; the man who writes a report on plant electrification or who draws up a set of building specifications, or who details the principles and features of some new contrivance, speaks quite another. To cite examples of a differentiation so obvious were surely superfluous. "My eye and I," as a theme subject is not even first cousin to "The relative merits of steam and electric draglines." "Scientific" German we have, but the German of one branch of science, say chemistry, is quite different from that of other branches, say anatomy or psychology. Just so, we have different sorts of English,—that of sports, that of belles lettres, that of Business, that of Engineering. This last, Engineering English, the student of Engineering should strive to master; because through it he will arrive at a better command of his technical subjects themselves. His technique is not the only technique; applied science, not the

only science,—hence, "technical" English and "scientific" English scarcely fit. But Engineering English is exactly coextensive with the medium of expression in which and through which the engineering mind is wont to act.

The business of the English department in any college of engineering is to provide a course which will meet the needs and come up to the proper standards of this profession. Keen perception, straight thinking, structural stability combined with extreme verbal economy,—accuracy, logicalness, orderliness, succinctness, this is what these standards amount to. In the first place, whether he writes or speaks, the engineer deals with definite subjects, with factual material, with determinable values and quantities. He is given to resolving these subjects into their component parts, and to reassembling them into some systematic, well-correlated, and well-articulated whole. In his expression he cuts down even the essentials to the quick. In every unit, large or small, he announces his intention, and in his progress he is scrupulous to fulfil these successive promises. With practice he comes to learn his way through the typical course of a technical article, and with familiarity gains in confidence and advances even to stylistic attractiveness and distinction. Than these, few things make more for prestige and professional advancement. This does not mean merely that some engineers learn to talk easily. Nothing is more antithetical to "talk"—to an invertebrate, round-about commenting on things in general, than the trained engineer's perspicuous, progressive, distinct and distinctive enunciation of some pertinent group of facts. Nowhere, once more, have we better evidence of training and ability.

Poor work is simply poor; a blemish more or less makes little difference. In work of a higher order, on the other hand, blemishes stand starkly out; and make one wonder how much of the apparent excellence is after all merely specious. Unconscious and habitual departure from good usage, whether in writing or speaking, spells ignorance and illiteracy. Unenviable signatures are "peaces of wood" and "the bubbel biscited by the cross hair." The *sine qua non* of efficiency, of effectiveness, is a mastery of form,—those forms at least which are a part of the everyday practice of

the profession. And besides form comes structure. A boxful of parts is not an instrument; a pile of stones is not an arch. The mere knowing of what one wants to say is a far cry from expressing it acceptably. "What?" and "how?" are *two* words,—worlds apart,—a whole education apart; and "why?" involves considerations a whole philosophy removed from both.

The purpose of this book is to aid the student of engineering in his efforts to develop along these lines of expression. Mainly its stress will be on accuracy and formal arrangement, as these are involved in the setting forth of engineering subjects. This course should follow a non-technical first-year course occupying itself with a consideration of the following subjects:

FIRST SEMESTER:

- The whole composition.
  - Subject and theme.
    - How to find it?
    - How to limit it?
  - Propositional outline and topic sentence.
    - How to make these analytically?
    - How to make these synthetically?
- The paragraph.
  - Amplification of ideas.
    - Notions of inherence.
      - Definition and details.
      - Exemplification.
    - Notions of relationship.
      - Comparison and contrast.
      - Causation.
  - Organization of ideas.
    - Unity.
      - Introducing ideas.
      - Summarizing ideas.
    - Coherence.
      - Connecting ideas implicitly.
      - Connecting ideas explicitly.
    - Emphasis.
      - Arranging ideas in "point" and focus.
      - Arranging ideas in mass and comprehensiveness.

Second Semester:

- Sentences.
  - Qualities.
    - Clearness.
    - Strength.
  - Punctuation.
    - Of the whole sentence.
    - Of sentence parts.
  - Words.
    - Denotation.
    - Connotation.
  - Phrases.
    - Idiom.
    - Correct usage.

This preliminary course, needless to say, provides an indispensable foundation for the advanced work in technical writing.

The latter course contemplates making each new subject the basis of a recitation. In preparing for such recitation each student outlines the main features of a chapter in his notebook. On coming to class five students are given slips each containing a topic for a four-minute talk covering some point discussed in the chapter. Each of these students goes at once to the board where he devotes ten minutes to the putting down of topics from which later to recite, using at this time his notebook but in no case his textbook. The rest of the class, meanwhile, are occupied with a written quiz. At the end of the ten minutes, the papers are collected, and one after another the speakers take their places at the board and discuss their several topics. These recitations are then made the basis of brief critical comment by the instructor.

The outline work in the first semester is usually called for in two installments, the introduction on one day and the body on another. After having been accepted, these outlines are written up in continuous prose.

The procedure followed in the case of talks is briefly as follows: Upon the making of an assignment, the students go to the Engineering Library and there search out a full-

length, well-constructed periodical article on the topic announced. A two- to four-page outline of this article is next made, in proper shape to be handed in; and from this in turn, a small speaking outline is made and arranged on cards. The talks are numbered, and a criticism of each one appears in the permanent notebooks. This exercise impresses on the minds of the student the best present-day practices of engineering literature; and at the same time that he is becoming familiar with these characteristic modes of engineering thought, he is fixing in his outline work the principles learned during the earlier part of the course, and accustoming himself to this new experience, that of serious oral discourse,—to a type of exercise that looks not to declamation, but rather to the developing of ability to "think on his feet."

Along with the oral work of the second semester go a few exercises in written composition; first, some definition writing; then, the preparation over the period of several weeks of an outline and article involving the use of books of reference: and finally, the writing of an argumentative paper and of a thought paper, the first in the form of an editorial or short newspaper article, and the second in that of an after-dinner talk.

Throughout the course, attention is devoted to matters of mechanical form, the assignment in connection with these lessons being often the collection of examples of the points under consideration. The question of hyphens and the matter of abbreviation are a live question and a matter of importance, not only from the academic standpoint but also from that of the practice of the profession.

A course program following this book might arrange itself somewhat as follows (the distribution of class periods in a two-hour course is shown by numbers on the right):

FIRST SEMESTER

Subject	Discussed		Due		Open
The process paper	1	2	4	6	5
Attention to manuscript	3				
The directions paper	7	8	10	12	11
Punctuation	9				
The apparatus paper	13	14	16	18	17
Capitals and italics	15				

The principle-of-operation paper....	19	20	22	24	23
Abbreviation..................	21				
Letter writing........	25	26	28	30	29
Spelling.	27				
Report writing..	31	32	34	35	36
Pronunciation.	33				

SECOND SEMESTER

The supply-of-materials talk	1	3	5	7	6
The definition paper	2	8			
Oral discourse.......... .. .	4				
The new-invention talk.. . .	9	11	13	15	14
The investigative paper.... . .	10	16			
Numerals......... .	12				
The relative-merits talk.....	17	19	21	23	22
The argumentative paper	18	24			
Hyphenation...	20				
The engineering-project talk . .	25	27	29	31	30
The thought paper........ . .	26	32			
The engineering vocabulary ..	28				
Specifications writing...	33	34	35	36	

Throughout this book an attempt has been made to preserve the atmosphere of Engineering. No difficulty has been experienced because of any dearth of topics on which to write. Surely no other field affords the student so many subjects, such serious subjects, and such live subjects on which to try his pen. Even to the layman they are subjects of interest; to the initiate in Engineering they have double interest. Where this quality of interest is present, good work may confidently be expected. Each several creature finds its sole delight in its own peculiar mode of active self-expression,—the grayhound runs; the eagle soars. To the engineer, consciously such, the writing of poetry, the writing of stories, have little meaning and even less of fascination. The modes of expression peculiar to his technical writing, on the other hand, appeal to him quite otherwise and elicit his earnest endeavor. Good work becomes the rule rather than the exception, as the high standards maintained in other Engineering subjects are brought over and applied in this. "Engineering," in short, is a word to conjure by; hence this course in *Engineering* English.

ENGINEERING ENGLISH

CHAPTER I

THE PROCESS PAPER

(Technical Narration)

A. The facts.

I. Process notions common to all.

1. Concrete notions.
2. Abstract notions.

II. Process notions peculiar to engineers.

3. Types of operations.
4. Limitation of operations.

B. The form.

III. Features common to all process papers.

5. Parts of the presentation.
6. Phraseology of these parts.

IV. Outlines adaptable to the main types of process paper.

7. Explanation.
8. Directions. (Comprises Chapter III.)

The earliest expression of the child is concerned with what it does; the most universal form of mature discourse occupies itself with the deeds of men and women, of groups and of nations. The ballad and the legend, the epic and the drama, novel and romance, history and biography, are alike concerned with a recounting of great achievements and adventures. Now in scientific literature, no less than in creative, we find an interest in what men do. Particularly does the applied scientist, the engineer, concern himself with such performance; for he indeed is the chief repository of

those arts by which civilization gets things done, and through such achievement becomes able outwardly to exhibit all that it means. Where such is the case, a main business of any course in engineering English must be to show what is meant by straight thinking and direct expression in this field of practical performance.

The Facts to Be Presented

In every scientific narrative the units of composition are the facts regarding what is done, items of verbal action directed in one way or another upon an object. In narration, these details of action are generally familiar to the writer and their proper sequence presents little difficulty, owing to their following one another in the unvariable order of time. The main problem of the writer, accordingly, lies in their grouping, in the discovery of the most natural system of coordination and subordination under which these sequent items can be arranged. As this grouping is not furnished by sense or memory, it must perforce be supplied by the mind. What experience perceives as an irregular concatenation of unit acts, the activity of mind organizes under a smooth succession of abstract verbal concepts, easy of comprehension, yet in literalness nowhere having actual existence. By this translating of the narrative process into a simple and symmetrical outline, the mind's grasp of it is greatly facilitated; and in all exercises of this character the mind of the learner is brought to a realization of existent factual relationships by being led on to them through stages known only to the understanding.

In the present chapter we have aimed to set forth certain of the *facts* involved in engineering processes, and then to present a few fundamental considerations of *form,* connected with the effective presentation, whether oral or written, of such material. Each of these heads we shall consider under divisions first general and then particular.

Process Notions Common to All

All general facts relating to process writing we find in the vocabulary itself out of which we build. We observe

them first in the names of actions performed upon material, either by simple manipulation or by the intermediate use of tools, apparatus, or machinery; and secondly, in the terminology used to express various conceptions of a less concrete nature, such as notions relating to the character of work, to the means of its accomplishment, and to the desirability and sufficiency of such accomplishment.

The advance in human achievements is by steps almost imperceptible. At each stage the present builds upon the past, and utilizes in every new development factors of achievement previously worked out as ends. Thus it comes about that the most intricate and involved of modern processes may by successive reduction be shown to consist of such elementary manual operations as pushing and pulling, raising and striking down. In his capacity of curator of these processes of production, the engineer as part of his professional training should master their integral notions most thoroughly. One of the proofs that he has a grasp of these his tools is found in his ability to differentiate and describe them. As illustrating these elementary operations we present the following,—ideas that fall variously under such heads as movement, placement, securement, shapement, treatment, and the like:

1. put, place, plant, station, established, orient, dump, jam, insert, superimpose, arrange, alter, adjust, align, space, level, plumb, center, focus, set, engage, hold, support, brace, secure, truss, wedge, tighten, fasten, fix, release, mount;
2. press, push, force, pack, crush, ram, tamp, drive, calk, compress, compact, condense, feed, convey, suck, lift, raise, hoist, erect, hang, suspend, elevate, pull, draw, haul, carry, convey, transfer, produce, transmit, distribute, empty, eject, expel;
3. slide, slip, shift, tip, tilt, incline, invert, overend, upset, capsize, reverse, depress, turn, twist, twirl, spin, whirl, coil, curve, rotate, revolve, gyrate, wind, screw, spread, wrap, swing, oscillate;
4. fill, cover, lap, backfill, puddle, inclose, encase, throw, sift, scatter, sprinkle, spray, screen, smear, pour, plunge, immerse, drain, discharge, join, bind, connect, unite, fasten, attach, mix, mingle;
5. combine, proportion, connect, tie, knot, splice, dovetail, bolt, nail, rivet, dowel, rabbet, clamp, clinch, lace, hinge, clutch, grip, stick, cement, glue, seal, separate, sort, distribute, segregate, dispose;
6. rub, knead, pulverize, scour, grind, scrape, file, abrade, polish, beat, tap, knock, mark, scratch, groove, inscribe, cut, carve, chisel, shear, saw, sever, etch, chip, notch, gouge, scarf, chamfer, sharpen,

point, taper, bevel, plane, trim, pare, tool, turn, shave, bore, tap, drill, punch, perforate, hollow, ream, thread;

7. bend, seam, stretch, shrink, elongate, expand, compress, tear, shred, gash, slash, slice, slit, split, splinter, shiver, break, crack, clean, finish, smooth, surface, polish, burnish, soak, drench, rinse, quench, saturate, boil, dissolve, distil, warm, heat, thaw, melt, roast, fuse, ignite, detonate, oxidize, temper, forge, weld, solder, cast, anneal, discharge, explode, blast;
8. cover, coat, smear, wash, brush, mop, sponge, plaster, spray, ink, paint, stain, varnish, shellac, japan, enamel, plate, stucco, tin, lead, tape, insulate, filter, coagulate, aerate, lubricate, mend, repair, correct, rectify, adjust, renew, renovate, regenerate, regulate, purify, refine, substitute, convert, replace.

But beside these actions of a concrete, visualizable character we have others whose nature is more general and abstract. The transition from the former class to the latter is observable in such terms as:

9. form, shape, build, prepare, devise, design, produce, develop,

wherein the idea is not so much that of a single physical action as it is of a complicated procedure involving many actions. In this abstract group we may also place such occupational words as:

10. work, job, task, project, calling, employment, trade, vocation, profession, process, practice, procedure, operation, usage, method;

such words for the collective means of production as:

11. tools, implements, instruments, utensils, contrivances, devices, machines, mechanisms, appliances, apparatus, machinery, accessories, piece, sample, specimen;

such words for intellectual processes related to the acquisition or communication of ideas as:

12. find, get, obtain, secure, assume, determine, choose, select, locate, establish, watch, note, notice, observe, read, scrutinize, distinguish, differentiate, survey, examine, check, inspect, compare, analyze, describe, discuss, explain, appraise, estimate, assay, scale, measure, grade, graduate, classify, integrate, calibrate, count, compute, figure, calculate, solve, formulate;
13. show, indicate, designate, specify, detail, copy, illustrate, record, draft, sketch, outline, letter, map, plot, diagram, tabulate;

and such words relating to the regularity or exactitude or desirability of performance as,

14. particular, special, specific, definite, general, usual, normal, habitual, customary, regular, standard, rough, loose, approximate, practicable, preliminary, tentative, careful, workmanlike, expert, professional, exact, accurate, correct, minute, scrupulous, good, useful, dependable, excellent, convenient, satisfactory, reasonable, efficient, effective, valuable, respectable, desirable, approved, allowable, permissible, advantageous, better, superior, exceptional, preferable, essential, necessary, indispensable, required, requisite.

Process Notions Peculiar to Engineers

In view of the infinite variety of processes associated with his profession, the student of engineering need be at no loss for subjects upon which to write. He may choose at will from topics the simplest or the most complex,—from those calling merely for the manipulation of material, to those involving the use of complicated instruments, or of huge machines. He may find a subject in drafting-room practice or in the endless projects in the field; in operations which we connect with the chemical and metallurgical laboratory, or on those others which we associate with highway and railway and sanitary practice. He may write on the work of the machine shop or of the pattern shop or of the foundry; or on the complicated operations of the electric laboratory or power house,—on any of the multitudinous problems connected with illumination or communication, or with the developing and transmitting and distributing of that power which has become so vital to modern industry.

Merely to suggest some of the verbs that might appear in the title should be sufficient to prove this multiplicity:

tracing, drawing, adjusting, chaining, setting up, laying out, referencing, running, constructing, laying, placing, applying, finishing, finding, determining, testing, measuring, charging, molding, turning, machining, setting, cleaning, locating, inspecting, soldering, wiping, winding, assembling, installing, calibrating, synchronizing, paralleling, connecting, tuning, checking, analyzing, titrating, causticizing, vulcanizing, preparing, making, manufacturing,

and so on endlessly. How many tests and adjustments! how many computations and determinations! how many things to be constructed! how many to be manufactured! Let us illustrate by indicating merely the sort of possibilities that are suggested by just two words of the foregoing list, —"making," and "determining."

Making.—the graph of a curve; the working drawing of a fly-wheel; a blueprint with a sunframe (or, a rotary machine); stadia measurements; the preliminary survey for a highway; the profile of a street; a highway survey in a severe rainstorm; a topographic map by the transit stadia method; solar observation by means of a sextant; a stadia azimuth survey of a farm; a topographical survey of a building site; a dry core; the pattern for a gear blank; steel by the electric cold-melt process; an automobile axle shaft; a storage-battery plate; a battery charger; a small spark coil; a simple potentiometer; a stray-power test of a shunt motor; an indicator diagram of a two-cycle steam engine; an industrial coal analysis; a bacteriological analysis of water; a normal solution; sulphuric acid by the lead-chamber process; hydrochloric acid.

Determining.—a meridian with a transit; the meridian by an observation on Polaris; the azimuth of a line by the azimuth of the sun; the latitude by Polaris at its upper culmination (or, by a circumpolar star); the grade of a slope; the area of an irregular figure; the fineness modulus of sand; the heat value of coal; the specific heat of a solid; optical rotation with a polariscope; the density of a steel sphere; vapor densities; the water rate of a steam engine; the horsepower of a motor; the brake-horsepower of a simple steam engine; the percentage of moisture in steam; the average pressure in a steam cylinder from an indicator diagram; the characteristic curves of a generator; the magnetization curves of a shunt generator, the mean effective pressure of a steam engine; the leakage coefficient of a series motor; the coöling coefficient of a magnetic cell; the resistance of the armature of a generator; the characteristics of a wound rotor induction motor; the efficiency of a shunt motor by the stray-power method; the properties of a lubricating oil; the specific gravity of dense irregular solids; molecular weight by the Dumas method (or, by the Victor Mayer method); the viscosity of water, the amount of free ammonia in water; the percentage of iron in an iron salt; the amount of carbon dioxide in limestone; antimony in commercial practice, the percentage of chlorine in a soluble chloride by the titration method.

Features Common to All Process Papers

In view of this wealth of operations that fall specifically within the field of engineering, the student may reasonably be expected to confine his attention to technical subjects. This means the avoidance of subjects dealing with general or merely casual information, such for instance as, "Starting a Ford," "Assembling a navy bunk," or "Writing up an experiment"; or again of topics dealing with unskilled labor, or the simple crafts, or with the trades, such for example as, "Sodding a terrace," or "Excavating a cellar," or "Constructing a bookrack," or "Wiping a joint," "Painting a

car," "Patching an inner tube," or the like. Difficulty, we should note, attends the adequate handling of such extensive industrial operations as are suggested in "The manufacture of portland cement," or, similarly, of gypsum roof tile, gypsum wall board, drain tile, terra cotta tile, pressed brick, or such other material; and as a general thing the student who has not had experience in building, let us say, automobile tires, or weaving large steel cables, will do well to confine his efforts to the explaining of the humbler operations of his own professional course. Let him, in short, avoid alike subjects that are too small for proper development, e.g., "Bisecting an angle," or "Sharpening a ruling pen"; and those that, conversely, are too large, e.g., "Prospecting for oil," or "Constructing a city water-works." Let him likewise eliminate such as are too indefinite, e.g., "The making of furniture," or "Classifying minerals"; and such as are bound up overmuch with intangible intellectual processes, e.g., "Designing an electric motor," or, "Appraising the value of a plant." Let him do this, and the field that remains is fairly open to his choice.

He may write, for example, on an entire process or on one particular stage of that process,—either on "The making of a cold chisel," or on the "forging" or "tempering" of a cold chisel. Again, he may explain comprehensively some general process, referring to its place in the field of science or of production, touching on its requirements as regards materials and apparatus, and explaining the method or methods of its accomplishment, or he may limit his discussion in any one of a number of rather well-defined ways. Such unrestricted processes are "Surveying," "Blasting," "Paving," "Tiling," "Blueprinting," "Electro-plating," "Waterproofing," "Differential leveling," "Thermit welding," and "Efficiency rating." As examples of restricted processes we may take those showing a particular directing of the verbal action, as "Profile leveling," "Grade running," "Contour mapping," "Stream gaging," "Concrete mixing," "Sound ranging," "Wood working," "Pattern making," "Glass blowing," "Valve grinding," "Valve setting," or "Water softening"; all of which operations, we note, may also take either the genitival or the objective form: "(The)

Inking (of) a tracing," "(The) Running (of) a grade," "(The) Calibrating (of) a galvanometer," "(The) Assembling (of) a radio set," or "(The) Measuring (of) self-inductance." Other processes are variously restricted, as by reference,

(1) to the particular object of the verbal action, as in, "Measuring the insulation resistance of a dynamo," "Measuring the electrical resistance of the primary coil of a transformer";

(2) to the object of the action supplemented by an example, as in, "The surveying of a rough land surface, such as a hillside pasture," "The gaging of a stream, such as the Iowa River at Iowa City," or "The making of a pattern for a flywheel, such as found on a —— engine";

(3) to abnormal conditions of performance, as in "Pouring structural concrete in freezing weather," or "Placing concrete abutments under water":

(4) to the place of performance, as in, "Repairing cracks and joints in concrete pavement," "Turning a taper on a round steel bar," "Setting a D valve on a steam engine," or "Measuring the current in a conductor";

(5) to the purpose of the performance, as in, "Setting grade stakes for a sidewalk," "Driving piles for a building foundation," "Testing portland cement for normal consistency," "Cutting a test station for noise," "Mixing cement pastes for testing purposes," or "Drilling a glass panel for a radio receiving set";

(6) to the instrument used in the performance, as in, "Dividing on a polyphase duplex slide rule," "Measuring areas on a closed figure by means of a planimeter," "Measuring the velocity of a stream by the use of a current meter," "Calibrating a voltmeter by means of a potentiometer," "Synchronizing a rotary converter with a synchroscope," or "Testing high resistance with a voltmeter";

(7) finally, to the method or process of performance, as in, "Adjusting the wye level by the peg method," "Locating a simple curve by angles," "Finding elevation

above sea level by spirit leveling," "Finding Young's modulus by the method of flexure," "Measuring an unknown resistance of a wire by the voltmeter-ammeter method," "Measuring an electric current by the weight-voltmeter method," or, "Comparing electrical capacities by Gott's method."

The Form

Once this matter of limiting the topic has been disposed of, the phrasing of the title still remains. Here the writer is confronted with the problem of form—a problem, by the way, less remotely associated with that of meaning than many realize. This title should be complete and accurate, grammatical and euphonious.

Distinctions can be drawn, for example, between, "Coal testing," "Making a test of coal," "Making a coal analysis," and "Making a proximate analysis of a coal sample"; and the same operation is by no means suggested by the titles, "Level adjustment," "Dumpy-level adjustment," "Adjusting the wye level," "How to adjust a level," "Field adjustment of the wye level," and "Adjustment of the level by the peg method." Differences of meaning exist, unquestionably between "laying," "building," "preparing," and "constructing" a concrete pavement: and the "getting," "finding," "obtaining," or "determining" of the indicated horsepower of a steam engine, forces upon us at least the *form* of choice. If the writer is considering steam pressure, he should ask himself whether he should use the word "finding" or "testing," "measuring" or "determining." Moreover he should indicate whether his interest is in the steam pressure of an engine; and if it is, whether it is with maximum pressure or with mean effective pressure. To write on "The bessemer process" is not to write on "The manufacture of steel," or on "The process of steel making"; and to announce any one of these titles when the subject properly is "The making of steel by the bessemer process" is a mistake.

In the process paper the *verbal* element is all important, so "*Making* a blueprint" is preferable to "Blueprinting." But having settled this we are confronted by numerous

phrasal possibilities: and because of rhythmical considerations we would change the former title to "The making of blueprints" for the sake of getting a stress pattern wherein the long and short, or stressed and unstressed, syllables show a symmetrical arrangement. Similarly, we should prefer "Testing steel for tensile strength" to either "Measuring the tensile strength of steel," "Making the tensile-strength test of steel," "How to test steel for tensile strength," or "Testing the tensile strength of steel." In general, phrases showing symmetrical patternry (a single extra unstressed terminal syllable being allowed) and those showing repeated iambs, dactyls, etc., will be found to be rhythmical.[1] Thus our ear prefers "Determining electrical resistance" to "The measurement of electrical resistance" or "Testing electrical resistance"; and it would substitute for "The magnetizing of iron" the more equilibrial arrangement "The magnetization of iron." "Testing oil for viscosity" is satisfactory in point of sound; but if we want to emphasize "oil" rather than "viscosity," we substitute "Testing the viscosity of oil," preferring this to the unsymmetrical pattern "Determining the viscosity of oil."

In all phrasing involving such verbal nouns in *-ing* as appear in these examples, the writer should remember that idiom requires that he use "the" before the noun whenever the noun is succeeded by "of," and that he avoid the use of "the" where no "of" is present.

In short, the title should be examined and re-examined. as a whole and in its every word, to the end that its verbal suggestion may exactly duplicate the idea in mind, general in one case, particular in another; now abstract, again specific and concrete. Here as everywhere words must be kept from talking for themselves, instead of for us,—from expressing some idea that we never had in mind to express at all. Intention, unfortunately, is not the measure of responsibility.

[1] See the author's *Rhythmic Prose,* University of Iowa Humanistic Studies, Vol. III, No. 1, Chap. II.

"Our words think for us," true enough; but sometimes, again, they think against us. We make no question of the character of the person for whom they think to best effect.

The Introduction

In the introduction the writer goes on to define still further the topic of discourse; first, by commenting on it, and secondly, by mentioning the heads of his discussion. His concern here is with a comprehensive setting forth of the object, action, or idea that engages the attention, in short, with the literal *defining* of the notion suggested in the title. Now this definition should be as exact and as technically workmanlike as the ability of the writer will at all permit. No definition that is merely passable but what actually retards our fullest comprehension. The definition "Testing steel for tensile strength is finding the amount of force per square inch necessary to pull a bar of steel apart," accordingly, the writer will work over into some such form as the following: "Testing steel for tensile strength we may define as the subjecting of a steel bar to the operation of forces gradually applied and acting uniformly upon its entire fabric in a direction away from its extremities, with a view to determining the amount of such force per unit area of cross-section required to effect a rupture." Now if to such a definition be appended statements bearing on the place of performance and on related operations, real progress will have been made toward focusing the notion in the mind of the reader. In order, however, still further to clarify the notion, the writer will do well to present it still again, this time in a concrete and analytic guise wherein its component elements are suggested separately to the eye and to the mind.

What are these essentials, these components? Every process presents us three sets of factors: first, we must consider the stuff *worked upon,* usually the object itself, or else the data or material from which it is derived; secondly, we have the instrumental means utilized, or *worked with,* in performing the operation; and thirdly, we have the steps, or *stages,* by which the work is carried out. Conditions

existent or raw materials, tools, instruments, appliances, machinery utilized,—these first two factors help us to visualize the situation confronting us. The last set of factors, or steps in the process, gives us the natural heads of the body of discourse, and should be selected, accordingly, with this fact in view.

We refer to this listing of the steps as the "division," finding in it the equivalent of the *partitio* of classical rhetoric, —that is, the "partitioning" off of the work into its logical divisions. It presents a close analogue to the "issues" which close the introduction of an argument. In such a statement of prospective heads we find the natural and normal sign that preliminaries are over and that the body of the explanation is at hand. The time-honored threefold method of presentation has indeed much to recommend it;—the telling first, in the introduction, what one has in mind to say; then the pointing out from time to time in the body that here and here and here these promised things are being said; and finally, in the conclusion, the reiterating that this and that and the other point have been discussed. This we may call the minimum *effective* presentation! Always important is the illumination of undeveloped darkness by such castings forward of shafts of remark to light up the course of intended procedure. By this means the audience is enabled mentally to adjust itself to the scope and character of the presentation; to keep its place, and effectually to correlate the successive stages by which the thought advances,—joining up what has been said with what is being said; and what is being said, with what remains to say.

The writer should bear in mind one or two particulars regarding this "division,"—the second or analytical part of the introduction of the discourse. The conditions under which the subject exists may sometimes require specific mention, as for example in the case following:

The construction of a box culvert that has been
    designed as to its
        placement
        and dimensions,
    and laid out on the road
        at the proper location
        and according to the chosen plan.

In the writer's mention of materials, also, he is always wise to let any error be on the side of exactness rather than of vagueness; by specifying tracing cloth, for instance, if that is what he means, rather than paper, and choosing according to the facts between such terms as ink, drawing ink, india ink, black india ink, or waterproof ink, or possibly water-colors for wash. Wherever possible, moreover, he should effect a grouping in this list of materials, and he may also to advantage append notes indicating the purpose of the several items. These points are illustrated in the ensuing examples. Thus in a paper on the making of dry cores he might write,

I. upon the following materials:
  1. sand which is naturally free
     from alumina,
  2. a binder, which must be an organic substance capable of holding the free sand together, such, for example, as we have
     y. in dry form in
        flour,
        rosin,
        and linseed oil;
     z. and in liquid form in
        glue,
        or molasses water.

In writing on the making of cement briquets he might, in like fashion, add to the bare terms as follows:

II. with the following apparatus:
  1. a steel trowel
     to mix the cement,
  2. a graduated centimeter-gram cylinder
     to measure the cement,
  3. a standard mold of brass or other non-corroding material to shape the briquets,
  4. a glass plate
     to support the gang mold and form,
  5. a beam balance with weights
     to weigh the ingredients.

In listing steps, finally, the writer should restrict each number to a single, separate stage in the procedure, avoiding, for example, such non-integral heads as appear in,

III. through the following sequence of main steps:
  1. finding the approximate center of the piece and punch-marking it,

2. clamping the piece in the chuck and placing the point of the short arm of the wobbler in the punch mark,
3. rotating the chuck and moving the piece until the long arm of the indicator ceases to wobble.

Subtopics under main operations should not appear in this "division" section, as for instance they do in the items under *a* and *b* below:

III. through the following sequence of main steps:
  1. setting up the level by
     a. planting the tripod legs,
     b. leveling the instrument,
  3. reading the back sight by
     a. sighting at the rod, and
     b. noting the figure showing thereon beneath the horizontal crosshair.

In some instances, however, the steps in the division may be grouped to advantage, as under such heads as "field work" and "office work"; or such again, as the Vicat or the Gillmore-needle method of testing cement, or the synchroscope or carbon-lamp method of synchronizing alternators, or the light-of-the-lamp or dark-of-the-lamp method of carrying out the latter of these. Such division to be useful must be simple and perspicuous and in full accord with all the facts. Where these conditions are met, its service is inestimable. Once the order has been determined upon it should be consistently followed, and all that is extraneous should be either eliminated or labeled *as* extraneous.

The Body

Suffice it to say that the body of the composition should be simple and logical, accurate and complete. The writer in this paper is not dealing primarily with structure, although in what he says he aims to be eminently structural; neither is he dealing with the exposition of an idea, although his composition should present a fabric of ideas continuous and compact. Instead, he is dealing with action and the facts of action,—with action that is unified, coherent, and essentially complete. As a result, the parts of speech he uses will be mainly verbs,—verbs not so much of ideation as of performance and accomplishment. He will hold to essen-

tials, and find no place for personal opinion; he will gage his treatment to the subject, to the audience, and to the occasion, working in all cases to scale, and aiming at a proportional development of coordinate parts. Throughout the work he will bend his every effort to keeping the matter well in hand.

The Conclusion

To balance the introduction we have the conclusion. This division affords the writer his last best chance to drive home whatever in his treatment he deems particularly essential, or to direct attention to whatever related matter outside the strict limits of his discussion he may hold important. The conclusion should in all cases be made to contribute positively to the totality of effect;—no empty gesture of finality will satisfy the requirements of this division. It must tell us more than any child should know; it must be informative and it must be convincing. What value in being told that engine horsepower is calculated "for the purpose of showing what load the engine can carry and for many other reasons"? This closing passage should effect an adjustment of the discussion to the needs of the audience. It should add to the body of discussion the element of import, of movement, of peculiar significance, of immediate concern.

The means at a writer's disposal for concluding a paper are various. He may confine himself rather strictly to the matter at hand, or he may pass in his closing remarks quite beyond the boundaries of this matter. He may summarize or he may recapitulate; he may comment either on the scale or on the degree of completeness of his discussion. He may stress the significance of the operation in the field where it belongs, or reiterate the critical importance of some certain stage of its performance. We suggest at this point a few examples. Of what importance is the testing of the insulation resistance of a cable? What will determine the choice of an operator between a common galvanometer type of voltmeter and one of the static type? What determines the choice, in coal testing, between the Beothier test or the Thomson-calorimeter test, on the one hand, and the adia-

batic-calorimeter or the Parr-calorimeter test, on the other? What determines the differences of precision sought in the preparation of indicator cards? Difficulties of performance, once more, either absolute or comparative, he may do well to point out,—such, for instance, as might occur in the operating of some complex machine; or such as might arise in determining when to pass from one operation to another.

But besides turning attention to the subject both as he has handled it and as it exists in itself, the writer may not do ill to direct his audience outside its narrow limits. Specific conditions may demand some special treatment; local conditions may suggest some application. The expanding of the field of vision through reference to related processes may appear advisable; or perhaps, finally, the indicating of the sources of information, practical or literary, where further investigation of the subject may profitably be pursued. These are some of the things that have in practice proved effective in this last division. Still other types of conclusion, however, will readily suggest themselves,—now looking to an increased comprehension of the process as it exists in itself, and again to a truer placement of the process as it exists in the general scheme of things of which it is a part.

Notes

The fact that extraneous matter is rigidly excluded from our outlines results in the use of notes for casual bits of information appositional or parenthetical. Illustrating the form of notes, we may take the following:

by

II. separating the reinforcing rods from each other and from the forms by wires and spacers.

Note.— These spacers may be
- x. stones,
- y. steel bridges or pieces of channel iron to be left in the concrete when it hardens, or
- z. wooden wedging blocks to be removed as the concrete pouring reaches them.

. . . . .

by

III. reading the stadia interval.

Note.—In cases where intervening objects, branches for example, so obscure the rod as to interfere with the reading

of the full stadia interval, the total intercept may be obtained by

y. reading the intercept between the middle and upper crosshairs, or between the middle and lower crosshairs, and

z. multiplying by 2

If for any reason, as following a field replacement of a broken wire, the horizontal crosshair is thought possibly to be out of its proper position midway between the stadia wires, a better method is to proceed by

y. reading the intercept between
the lower stadia wire and the middle crosshair, and then (moving the line of sight),

y. reading the intercept
between the upper stadia wire and the middle crosshair, and

z. adding these two partial intercepts.

Needless to say, careful attention should be given to the *form* of notes. Consider for a moment the presentation of the following:

(Note:—Go through the same procedure with stakes # 3 and # 4)

Here no parentheses should be used; "Note" should be followed by a period and dash; no signs should be used before the figures; and a period should appear at the end. Moreover, the material should in the first place not be a note at all, but a step, or two steps, in the process; and it should not, finally, have been phrased in the imperative. Otherwise, if we accept the small *s* for "stakes," it is fairly correct.

Illustrations

Frequently a diagram accompanied by lettering and references, is all but indispensable. Few are the processes that are not rendered more intelligible by the use of illustrations. What words can duplicate the clearness of the pictured setup of physical or of chemical apparatus? Pictured, a wiring diagram is immediately intelligible; expressed in words, it may only confuse. The same is true of the layout in level adjustment; and in stream gaging, of the instruments, and the weirs, triangular trapezoidal or rectangular, and possibly also of their position or placement in the stream. Nothing, in short, can equal the sketch for showing shape

or size, more particularly when any element of comparison or contrast enters in. Thus in a machining job, the writer may picture the peculiar shape of his "⅝-in. pin"; or his machinist's "button"; or the method of applying to the irregular piece his inside micrometer or vernier caliper. Or, in a paper on centering work in the lathe, he may refer as follows to an accompanying figure:

> y. "a wobbling-center indicator (Fig. 1) which consists of
> w'. a long needle *N*, mounted on
> x'. a universal joint *U*, and attached to
> y'. a shank *S*, which attaches in turn to
> z'. the tool holder of the lathe *T*; and
> z. a pair of outside hermaphrodite calipers (Fig. 2);" *etc.*

Although photographs and tables may occasionally be used, in the sort of work with which we are at present dealing, the sketch will more often prove of service. In the directions paper, of course, it will tend toward the schematic character of a working drawing.

Outlines Adapted to the Main Types of Process Papers

We take up now the presentation of a form of continuous outline applicable to use with any process paper dealing with explanation.

Once the title is composed, and centered exactly, and thrice underscored for full capitals, the writer goes on, after leaving one vacant line, to the business of the introduction. The word "Introduction" (twice underscored for small capitals, and the "I" thrice underscored for capitals and without preceding symbol) is placed flush with the margin. Following it is a period, and after this, within parentheses, a specific statement of the content of this division, itself followed by a period. The further arrangement as regards order and indention, punctuation, phraseology, sequence of symbols, and disposition of carried-over material, appears in the following skeleton outline, to which model the student's exercises should conform with all possible closeness. In this outline, words of direction appear italicized within brackets, and words to be taken over onto the finished out-

line appear with them in ordinary type. Attending to this work should accustom the student to adequate standards of organization. Once this pattern of adequacy is in his mind, he will not be satisfied with any makeshift approximation. To this end, then, the rubber stamp,—the stereotyped service of the dotted line. Just as a composite photograph of many faces reproduces the features common to the group, so this skeleton outline provides for the essential aspects of any process paper.

(THE TITLE)

INTRODUCTION. (Definition and division.) The nature of the operation.

A. ......ing [*Supply a verbal noun expressive of the general operation, and follow this, where circumstances require it, by an object*] we may define as the ...... [*select the appropriate word, e.g.*, process, operation, *etc.*] of ...... ing ...... [*supply an object of the verbal noun*] so as to ...... [*complete the sentence*]. It [*or, substitute for "it" the name of the process*] is

I. performed in ...... [*state where the work is done, e.g.*, the field] by

1. ... [*state by whom the work is done. This formal exercise is greatly improved by having double or multiple subtopics (not too many, however) in every case. This effect should generally be sought even by recourse to some slight fiction. Where in exceptional cases no more than one subtopic can be found, that one appears as part of the larger topic preceding and is given no symbol*], and by

2. .. ...; and is

II. related to the operations of

1. ..... [*supply a verbal noun, with an object if this is required*] and of

2. ... .

B. The ......ing of (a) .. ... [*supply a verbal noun descriptive of the specific, concrete operation presented, and as in A follow this by the objective genitive in the of-construction.—Add, wherever practicable, the clause*, such as we have in the ......, *mentioning here known conditions, or referring here to an accompanying sketch*] presents a ...... [*supply an appropriate word*, typical, special,

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etc.] case of . . . . . . ing . . . . . . [*supply object of verbal noun if one is required*] which involves a working

I. upon the following . . . . . . [*supply the appropriate term,* objects, materials, data, marked positions, *etc.*]:

1. . . . . . . which . . . . . . [*supply a verb,* is, are, has been, *etc.*, followed by a brief description] . . . . . .,
2. . . . . . . which . . . ., and
3. . . . . . which . . . .;

II. with the following . . . . . . [*supply the proper term,* tools, instruments, apparatus, *etc.*]:

1. . . . . . . [*supply, where practicable, brief descriptions; or references to illustrations, e.g.,* such as appears in . . . . . .],
2. . . . . . ., and
3. . . . . . .; and

III. through the following sequence of stages, or main steps:

1. . . . . . ing the . . . . . ,
2. . . . . . ing the . . . . . ., and
3. . . . . . ing the . . . .

Body. (Exposition of the process.) . . . . . . ing . . . . . . [*supply the verbal noun and its object*], then, is a . . . . . . [*supply the proper number, making a solid compound*] -stage process.

A. The first stage is to . the . . . . . [*supply an infinitive and its object; and add to this any necessary adverbial modifier, telling how, where, etc., the work is done.* The . . . . . . [*the object of the infinitive just above here becomes a subject*] is . . . . . . [*the infinitive here becomes a past participle, which is followed by any necessary adverbial modifiers*] by

I. . . . . . . ing (the, a) . . . . [*supply a verbal noun with its object and possible adverbial modifier*], doing which requires taking the following steps:

1. . . . . . . ing (the, a) . . . . . . [*verbal noun, object, and possible modifier*] which is done by

Note,—All arabic figures are introduced thus; all roman numerals, by "doing which requires," etc.]

a. . . . . . . ing (the) . . . . . [*verbal noun, object, and possible modifier*],
b. . . . . . . ing (the), ... and
c. . . . . . . ing (the) . . . . . . [*note this formula cannot, of*

course, indicate the number of heads falling in any part of the outline]; and, after this,

2. ......ing (the) ...... [*supply as before*] which is done by
   a. ......ing (the) ......, and
   b. ......ing (the) ......; then

II. .... ing (the) ...... [*supply verbal noun, its object, and adverbial modifier*] doing which requires taking the following steps:

1. ......
   a. ......
   b. ......
2. ......
   a. ....
   b. ....ing (the) ......; and then

III. ......ing (the) .... . etc.

B. After the .. ing of the .., the [*supply* next, *or* final] stage is to .., etc.

The filling in of this outline will lead occasionally to further symbols, indicative as a rule of duplicated descriptive matter. Such details we regard as extraneous, and so place them to the right of the regular material and use as symbols for them as many lowercase letters as is necessary back from the end of the alphabet. For a subordinate, or secondary, series, the corresponding "prime" forms can be used, i.e., x', y', z'. First we consider such cases as may recur in the introduction:

I. upon the following materials:
1. alloys which have
   y. such chemical properties
      as will insure proper hardness, and
   z. such physical properties
      as will
      y′. insure a smooth surface
      and
      z′. prevent the impairment of the finished product.

. . . . .

I. upon the following materials:
1. water which is free from
   w. vegetable matter, or
   x. other organic matter,
   y. saline matter,
   z. alkaline matter; and

x. sand
  y. from Ottawa, Illinois,
  z. of a size such as will be
    y'. passed by a No. 20 sieve, and
    z'. retained to the extent of 99 percent. by weight on a No. 30 sieve.

The principles observed here are equally applicable to the following apparatus section. We take up next Section III, dealing with the stages of the operation.

Much of the difficulty later encountered in finding subtopics arises from a failure to secure generalized words for the main topics. For example, if a writer starts out with "sprinkle the sand," he at once finds himself at a loss for further subdivision; whereas, if he begins with "wet down the sand," he can introduce topics bearing on the provision of the water and the mechanical means of its distribution, and so finally arrive at the sprinkling, or spraying, or pouring, or slopping, or soaking, or saturating, or whatever other term circumstances require.

Members logically coordinate should at every stage be brought into the same form of phrasing. The value of such procedure will appear from a comparison of the following arrangements:

III. through the following sequence of stages, or main steps:
  1. fastening the wood in the lathe,
  2. turn to the required diameter,
  3. and taper the sides a little,
  4. then you cut it off as desired;

III. through the following sequence of stages, or main steps:

1. placing	the piece	in	the lathe,
2. turning	the piece	to	the required diameter,
3. bringing	the sides	to	a slight taper, and
4. cutting off	the piece	to	the length desired.

The analytical outline for the body of this expository paper shows the same mechanical, "rubber-stamp" characteristics that marked the introduction. Flush with the margin, and underscored for capitals and small capitals, appears the word "Body." Following this as in the preceding division comes a statement of its general intent (in parentheses), succeeded by a more explicit statement of the character, of the process under consideration. All formal details, save

of course phraseology, are the same as in the introduction. The phraseology of explanation will, of course, differ materially from that of directions.

Criteria of taste we here set aside for those of straight thinking and rigorous statement of fact. Beauty concerns us only as the last word of clearness becomes beautiful; force, only as marshaled sequences moving steadily from start to predetermined end gain in cogency in the progress of their advance. Clearness, this above all, is what we want,—clearness at every step; definiteness in the denotation of words; perspicuity in the procession of sentence parts. Our ideal is a fabric of information that is accurate and logical and on its chosen scale complete and adequate.

In process writing the first essential is the thing which is done; the second is the object of this action; and the third is the manner of performance. In our outlining we shall observe at each advance this sequence of factors; for example,

The circuit is tested by
I. connecting the primary to the
110-volt circuit;
II. connecting the leads to the
battery terminals; and
III. adjusting the rheostat so
that the ammeter shows a charging rate
of two amperes.

In accordance with this rule, transposition is made from such forms as "sighting on the given point" and "carefully manipulate the dials," into the forms, "taking a sight on the given point" and "manipulating the dials carefully." This adverbial material, which is sometimes phrasal, sometimes clausal, sometimes single in its occurrence, at other times double, serves to express a variety of relationships, among which we find such as the following: time, place, direction, degree, extent, amount, manner, means, method, respect, condition, purpose, and result. Illustrative of its general nature are the examples listed below:

adjusting the crosshair until it bisects the target
reading the scale at the end of five minutes
checking the movement of the counterpoise the moment the bar breaks

clamping the glass cover on the frame
reading the angle on the vertical scale
measuring off 100 ft. to the right
setting the tailstock approximately 2 feet from the headstock
mixing the sample thoroughly
reading the rod to thousandths of a foot
increasing the speed to 5000 r.p.m
adding common salt equal to 1 per cent of the weight of the water
    for each degree below freezing
taking the tensile strength in pounds per square inch
connecting the coils in series
laying the tracing cloth so as to cover all the drawing
cutting and fitting the lumber so that the inside dimensions of the
    form are equal to the outside dimensions of the culvert
adjusting the telescope by means of the capstan-headed screws
measuring the elongation with a steel rule
drying the sheet by hanging it on a rack
comparing the horizontal hair with any apparently level line
disconnecting the armature from the frame if any connection exists
adjusting the lower-plate bolts so that they are free from strains
placing the drawing in the frame face down
leveling the instrument carefully over one set of screws
turning the screws gently to the left
stirring the mixture gently for about three minutes
reading the compressive force from time to time in order to plot
    errors
keeping the beam constantly in balance
measuring the diameter in six places with the calipers
clamping the bar horizontally to some rigid object
bringing the motor to the desired speed by the use of the field
    rheostat
fastening one end of the bar with a lathe dog so that the bar will
    revolve with the headplate.

Extraneous material, that is, such as does not belong under one of the heads, verbal noun or object or modifier, we set back to an alignment one step to the right of that of the carried-over lines. Thus we write,

The unknown resistance is connected in the circuit by
I. manipulating the resistances
    y. in the primary circuit, and
    z. in the secondary circuit.
This is done by
I. connecting the ammeter in series with
    y. the high resistance, and
    z. the variable resistance.
The oven is heated by
I. passing a current
    v. from the large battery *K*,

w. through the variable resistance *R*,
x. through the heating coil *A*,
z. over the level of the fulcrum *F*, and
z. down through the platinum point *H*.

Our "stages," under the capital letters are, as the reader will see, generalized and abstract. The headings of the next order, under the roman numerals, are semi-generalized, —less expressive of unit action than they are of actions combined for easier comprehension. The arabic figures cover the main list of such steps as are concrete; while the lower-case letters embrace, in the main, minor and incidental points of procedure.

Where a verbal form occurs in the third place (that detailing manner of performance), the writer must assure himself that it is indeed logically subordinate to the verb upon which it depends. This determination is often facilitated by reference to the general coordination. As examples of these troublesome alternatives we may take,

adjusting resistances by shifting resistance plugs
shifting resistance plugs to adjust resistances;

keeping the speed of the generator constant, so as to hold constant the frequency of the applied e.m.f., and

holding the frequency of the applied e.m.f. constant by keeping constant the speed of the generator;

joining the other side of the crystal and the loose end of the phones together thereby making the set ready for operation

completing the operation by joining together
y. the other side of the crystal and
z. the loose end of the phones;

noting whether the direct and reflected images seem to overlap laterally, doing which requires

moving the vernier until the direct and reflected images seem to overlap.

The purpose, or end, of action usually outranks the means to its accomplishment; but straight thinking alone can determine this point with absolute surety. Cases of subordinate purpose appear in the following:

setting the briquets aside to harden
consulting the dial to see that the hand is revolving
leveling the surface so as to prevent unsightly irregularities
adding carbon to strengthen and harden the steel.

Throughout this exercise each member should include but a single verbal action. All such combinations as the following should be avoided:

removing the blueprint from the frame and developing it
sliding the indicator to the right and setting it at the index.

The second arrangement in each of the two following examples is always to be preferred:

taping the winding with a layer of cambric and varnishing the layer
protecting the winding, which is done by
a. taping it with a layer of cambric, and
b. varnishing it after it has been wound;

balancing the bridge roughly by estimating the unknown resistance and setting the bridge accordingly
balancing the bridge roughly, which is done by
a. estimating the unknown resistance, and
b. setting the bridge accordingly.

In such cases even as "reading and recording the ammeter indication," and "cleaning and polishing the anode," the admittedly academic purposes of this exercise would advise a division despite the close relationship of the actions in point of fact.

The greatest impediment to straight thinking is that presented by false coordination; by running in parallel items that are abviously senseless, such as we see in,

This is found by
I. reading the potentiometer and
II. multiplying it by 10;

or again, by any mere outlining to the eye, such as appears in,

The office work is done by . . .

IV. averaging the mean average velocities for each section to find the average velocity for the total stream;

or, once more, in

The involute is constructed by

I. drawing a circle
  1. with the compass,
  2. which is divided into equal arcs,
    a. with dividers
    b. which are measured by
      y. stepping into equal divisions and
      z. counting these divisions.

As further examples of poor arrangement, and of suggested emendations, the following are presented:

The voltmeter is read with the unknown resistance in series by

I. placing the unknown resistance in series with the voltmeter doing which requires taking the following steps:
  1. connecting in the source of supply previously used,
  2. noting the reading of the voltmeter,
  3. recording the reading.

Here Points 1, 2, and 3 should appear as II, III, and IV, coordinate with Point I.

The rod reading for grade is determined by

I. taking a "plus sight," which requires
  1. sighting the instrument upon
      y. a starting point of
      z. known elevation, and
  2. figuring the height of instrument by
  3. adding
      y. the plus sight to
      z. the elevation, and
  4. subtracting from
      y. the height of instrument
      z. the elevation of the grade at the same point.

In this case false coordination greatly impedes the grasping of the thought. Let us revise to read as follows:

The rod reading for grade is determined by

I. taking a "plus sight," which step requires sighting the instrument on a turning point of known elevation; then
II. figuring the height of instrument by adding to the elevation of the turning point this plus sight; and then
III. subtracting from the height of instrument the elevation of the grade at the point where the rod reading is required, i.e., at the station where the slope stake is being set.

Similar confusion appears in the next example:

I. making the test with engine running, doing which requires taking the following steps:
  1. starting the engine, and
  2. speeding up slowly while the ammeter needle remains at zero until by
  3. bringing the engine speed to the equivalent of a car speed of 7 to 10 miles per hour,
    a. the cutout should close and
    b. the ammeter should register the charging current; and then
  4. throttling slowly until
    a. the speed has been decreased sufficiently so that
    b. the ammeter needle will read backwards when the engine speed is equivalent to a car speed of 5 to 7 miles per hour, when
    c. the cutout opens and
    d. the ammeter again reads zero.

This we interpret to mean essentially the following:

I. making the test with engine running, doing which requires taking the following steps:
  1. checking the reactions proper to an increase of speed by
    a. increasing the engine speed gradually to what would be a car speed of from 7 to 10 miles an hour, and
    b. observing meanwhile whether
      y. the cutout closes, and
      z. the ammeter registers a charging current; and then
  2. checking for the reactions proper to a reduction of speed by
    a. decreasing the engine speed gradually to what would be a car speed of from 5 to 7 miles an hour, and
    b. observing whether
      y. the cutout opens, and
      z. the ammeter again reads zero.

Of such false coordination we present one more example; dealing this time with the measuring of differences in potential:

The circuit is balanced until the galvanometer of the potentiometer shows a zero deflection for the standard cell by setting

I. the dials of the potentiometer to the value of the standard cell; and
II. the value of the resistance-controlling storage-cell current.

This we work about into the form:

The circuit is balanced by

I. setting the value of the standard cell on the dials of the potentiometer; and then

II. adjusting the value of the resistance controlling the current from the storage cell until the galvanometer of the potentiometer shows a zero deflection.

The conclusion is carried out along the same lines as were the other main divisions. It should be organized as were they, and should be presented in outline form. Here, as in the earlier parts, extreme economy of presentation is to be sought. The example that follows, for instance, might by the writing in of "when" after "calibrated" be reduced to the extent of omitting the entire part that is italicized:

Voltmeters are calibrated [when]

A. *when the instruments are first* manufactured,

B. *when the instruments are* thrown out of calibration by *reason of* wear or abuse,

C. *when the instruments are* repaired by the replacement of *new* parts,

D. *when they are about to be* used *with new multiplying coils* for any range of voltage other than those for which they were *originally* designed.

Verbal economy should prevail from start to finish. If "the bubble axis is set perpendicular" suffices, to write "the bubble axis is next so adjusted that it will be perpendicular" is to err. Where "baking them for two days" is adequate, the writing of "allowing these blocks to remain under the action of heat for the space of forty-eight hours" is inexcusably wordy. The fewer the words, the less resistance does language offer to communication. But along with conciseness should go accuracy and completeness; and with these, a feeling for what we may call the normal movement of well-ordered speech.

We note, finally, a few points of form of general applicability. Underscoring, and the punctuation of every symbol and every line end, have already been emphasized. We might add the desirability of putting quotation marks about such terms as appear in

the "minus sight" column of the notebook;
this form, known as the "batch mixer";
holding the abrasive wheel, or "arbor."

"The ingredients are thouroughly mixed" reminds us of the necessity of checking the spelling. Incidentally, we prefer "the foregoing" to "the above"; "Points 1 and 2" to "points

(1) and (2)"; "Note.—" to "Note." or "Note:"; "Fig. 1" to "Figure 1"; and, in a word, all the multiplicity of forms recommended in the interchapters.

The intention of these outlines should by this time be clear:—to reduce a presentation to its briefest possible form; to arrange these essentials in their logical, by which we mean their most natural, order; and to indicate—and doubly indicate—that order and that relationship. In any arrangement of a scheme of physical facts, once a particular line of treatment has been evolved, one proper place exists for every separate item, and every separate item should appear in that place and nowhere else. Each case that arises presents a new problem, and one which it becomes the business of the writer to think out to solution. "Thinking out" rendered concrete and visualizable, appears in the successive more or less abstract heads that in our outline fall in systematic and organized arrangement to the left of the inherently promiscuous and only casually related concrete details upon the right.

Certain things belong in the introduction and should be found there. Never so late as in the body should we be held up by the information that "The material is prepared by pulverizing a commercial sample of between 25 and 30 lbs. weight"; or in the case of apparatus, to be told that, "The briquet is molded by packing some of this mixture into a form which is glazed so that the cement will not stick to it, and hinged so that the form may be removed without injury to the briquet." Similarly, the body and the conclusion call each of them for a certain sort of information.

In conclusion, this work will not be judged as being more or less effective in grace or imaginativeness or oratorical eloquence, but it will be judged in each detail as right or wrong. Layout, punctuation, phraseology, and sentence form, all these can be checked. Each new process must be reduced into its true and ultimate constituents, and these unit parts, verbals, objects, and modifiers, must be so organized and articulated as to present a continuous fabric of fact altogether satisfying to the mind. This is the problem; problems are to solve. The solving of problems in the field of enterprise is the peculiar function of the engineer.

CHAPTER II

THE ATTENTION TO MANUSCRIPT

A. Text.

- I. Appearance.
  - 1. Shaping.
    - *a*. Materials.
    - *b*. Legibility.
  - 2. Spacing.
    - *c*. Margins.
    - *d*. Indentions.
- II. Composition.
  - 3. Headings.
    - *e*. Inscriptions.
    - *f*. Superscription.
  - 4. Ranking.
    - *g*. Symbols.
    - *h*. Slip-under sheet.

B. Illustrations.

- III. Graphical representation.
  - 5. Introductory.
    - *i*. Function of the sketch.
    - *j*. Preparation for the sketch.
  - 6. Preliminary.
    - *k*. Type of drawing.
    - *l*. Arrangement of the drawing.
- IV. Supplementary considerations.
  - 7. Writing on the drawing.
    - *m*. References.
    - *n*. Inscriptions.
  - 8. Drawings in the text.
    - *o*. Symbols in the text.
    - *p*. Figures in the text.

Text

Materials

Paper should be of good quality, clear white, tough, and semi-transparent. For handwritten copy it should be lined at ⅜-inch intervals. This will give on the standard sheet, 8½ by 11 inches, from 21 to 24 lines to the page. Typewritten manuscript should be on paper that is unruled. Work in either case should be confined to one side of the sheet.

The *Pen,* where one is used, should be in good condition, and any typewriter used should be properly cleaned and equipped with a fresh ribbon, preferably black. *Ink* should be distinctively dark, more particularly black, or blue black, never green or purple, red or violet. The sharper the lines and the greater the contrast between the writing and the paper, the more effective will be the impression of the whole.

Legibility

Penmanship should be regular, of uniform slant, and considerably smaller than babyish without being minute. From seven to ten words to the line may be considered to represent the number best from the viewpoint of legibility. But the ideal is not mere legibility; rather, a positive attractiveness. Capitals and symbols should be small and neat. No vagrant dots or slashes in *t*-crossings, or wildly flourished loops or interfused final letters, should ever appear. Scratched-out words or strikeovers should never occur; erasures should always be carefully made; and interlinear insertions should be attended to with the utmost care and painstaking. *Punctuation* should in all cases be immediately identifiable. All periods, commas, and semicolons should be placed accurately on the line, as also should the lower points of parentheses and marks of interrogation. Dashes should be given three times the length of hyphens. The intended position of quotation marks should be indubitable. Every apostrophe should stand in an open space. In typing, a single space should be left after every mark of punctuation occurring in the midst of a sentence, and double spaces should

be left after all punctuation that is final. Symbols should in all cases be brought sharply to alignment, and text should everywhere be brought closely up to symbols.

Margins, etc.

Down the left side of the sheet, a margin of 1 in. (or, if typed, of 1¼ in.) should be observed, this margin to be measured from the edge of the paper or from the center of binding holes where these occur. On the right, a margin of approximately ¾ in. should appear. Where the text is unlined, an open space, the "heading," should be left extending down 1¼ in. from the top, and to balance this, a space at the bottom extending up 1 in. should be left. The contrast between the white and black sections of the paper is a material factor in general esthetic effect. Attention to these particulars, together with care to leave ample space between titles and divisions, between divisions themselves, and before and after cuts, will contribute greatly to the attractiveness of the paper..

Indentions

Indention is used to indicate paragraph beginnings (together with the omission of a line in typewritten copy), tabulated material, and quoted material where the latter extends over two or three lines. Paragraph indention in handwritten copy should be 1 in.; in typewritten copy, when double-spaced, ten spaces, when single-spaced, five spaces. In outline work, indentions should occur at intervals of ½ in. beginning at the left-hand margin. In typewriting the half inch is equivalent to five spaces. In exceptional cases (more especially with typewritten work) where the lines are short, ¾-in. indentions will give a most attractive effect of balance on the page. These several vertical alignments may be indicated either by drawing them on the sheet and later erasing them, or by using such a slip-under sheet as is described on page 37.

Composition

Inscriptions

All inscriptions should on handwritten papers be in lettering, and, save in the case of abbreviations, should not be followed by periods. The designation "Exercise —" should be placed close up in the upper left-hand corner. Inasmuch as single assignments may not in all cases cover the whole exercise, the exercise number may be followed by one or more of the lower-case letters *a, b, c, d,* or *e,* to indicate respectively the inclusion of the *introduction,* the *body,* the *conclusion,* the *drawing,* or the *entire paper.* Immediately below the exercise designation should appear the *date,* with the month either spelled out or written in literal abbreviation. The *writer's name* (surname, followed by given name or initials, e.g.,—Mann, A. Z.) should appear at the top of the right-hand side of the first page, to be followed in the middle of this side at the top of each subsequent page by the author's initials (e.g.,—A. Z. M.). This position, be it noted, is preferable to that on the right owing to the greater ease of identifying the sheets of a paper when leafing over a pile of manuscripts. *Page numbers* run consecutively throughout the article, beginning with an arabic figure 2, without following period, in the extreme upper right-hand corner of the second page. The *title* should in all cases be accurately centered at the head of the article. In handwritten manuscript it should appear in the first line; and in typed manuscript, it should be so placed as to bring the top of its letters not nearer than 1 in. to or farther than 1¼ in. from the top of the page. It should appear in lower-case letters, save for the conventional capitalization of its principal words; and should have triple underscoring to indicate FULL CAPITALS that would be used in print. These underscorings should be in straight continuous lines made with a ruler where the paper is handwritten, and with the machine where it is typed. Any following subtitle should be separated from the main title by a one-line space; and between the body and such title or subtitle a one-line space

should be skipped in handwritten manuscript, and two in typed.

Division headings may be centered accurately on the page with double underscoring in straight lines and first letters of words triple underscored, to indicate the CAPITALS AND SMALL CAPITALS of print. Sectional headings may be placed along the left margin, where they may occupy a line by themselves or stand at the head of a paragraph. In the former case they are set back from the margin one-half the distance accorded paragraph indention. Neither centered headings nor isolated marginal headings take a following period; but when sectional headings occur in a paragraph, they are regularly followed by a period and a dash. These side headings may be underscored, either with one straight line for *italics*, or with one wavy line for **black-face** type. Where, as in this chapter, both forms are used, the latter takes precedence of rank.

In outline work the words Introduction, Body, and Conclusion should be written close up to, but not touching, the left-hand margin. They should all be lettered in lower-case with initial capitals; they should be followed by a period; and should be underscored by two straight lines, with initial letters triple underscored, to indicate capitals and small capitals.

Superscription

Wherever manuscripts are folded, the following suggestions may make for effectiveness. Fold the paper lengthwise so that the right edge comes over on the left. Then on the upper surface (what in a book would be the back) draw light lines 1¼ in. and 3¼ in. from the top. Between these lines, and above a space left midway between them, write, as inside,—Exercise —, and below this the title, this time within quotation marks and, bibliographical fashion, with only initial capitalization; and with no following period. Below the middle space write first the name, and under this

the date, as on the inside. This indorsement on the back rather than the front permits, when the paper is with others in a sheaf, the turning over of the papers as units, rather than as a confusion of pages.

Before being handed in, papers left in the flat should be fastened together by a paper clip placed in the upper left-hand corner.

Symbols

Symbols are used in this book in the following sequence: for the simplest tabulations, *1, a;* for tabulations somewhat more involved, *I, 1, a;* and for full-length elaborate tabulations, *A, I, 1, a.*

Inasmuch as the more general headings are fewer in number than the subheadings that fall under them, and inasmuch as the sequence of letters is shorter than is that of figures, the most reasonable order of symbols would appear to be *A, a, I, 1,* or at least *A, I, a, 1.* The former of these has the advantage of making the literal symbols stand for the more abstract conceptions, and the figured ones for the more concrete; and the latter arrangement has the somewhat academic advantage of alternation between letters and figures. The sequence that we have chosen for use in this book, however, has behind it the authority of almost universal practice as regards *1* and *a,* and the further advantage of throwing back the symbols easiest to write into the positions of greatest frequency. In more complex material *w, x, y,* and *z,* are set to the left beyond the position of the carried-over lines to indicate cases of coordination in material extraneous to the main sequence of the paper. Symbols should be lettered, not written in script; and should be fairly small in size; evenly inclined; and placed in accurate alignment,—roman numerals, be it noted, align not upon their first stroke, but on their following period. In reading symbols convenience is promoted by saying for *1,* "one"; for *a,* "aye"; for *A,* "cap-aye"; and for *I,* "cap-one." By the allowing of these slight fictions, much awkward reference to "roman" and "arabic" and "lower-case" this and that and the other is avoided.

Slip-under sheet

Extremely useful in our outline work is a sheet lined out as follows: Across a sheet of stout bond paper, 1 ¼ in. down from the top, draw in black india ink a line to serve as a reminder of the height of the title, and of the upper inside lines of the manuscript. Next, 1 in. in from the left border, draw a margin line of medium weight from this cross line to the bottom of the page. (On this line come the three main divisions of the paper.) Follow this toward the right at intervals of ½ in. (= five typewriter spaces) by other black lines of the following weights: A light one for the *A, B, C,* etc.; a heavy one for the *I, II, III,* etc.; a medium one for the *1, 2, 3,* etc.; a light one for the *a, b, c,* etc.; a double one for all carried-over lines of whatever rank. Then draw the following red lines at the same ½-in. intervals: A heavy one for *y, z,* and any letters (*x, w, v,* etc.) that may precede them; a medium one for *x′, y′,* etc.; a light one for *x″, y″,* etc.; and a double one for the carried-over material in such extraneous tabulation.

Now 2 in. below the horizontal line at the top and between this double red line and the right border, draw a horizontal line to indicate, along with the head line, the position of the superscription on the back of any folded exercise; and, finally, enter for reference in this space and also at the top of the sheet examples of the conventional forms to be used in preparing manuscript:

> Exercise 3
>
> "Laying concrete in
> freezing weather"
>
> Mann, A. Z.
> April 1, 1928

The writer who has begun by carefully attending such preliminary matters has a stake in his work that is likely to effect the improvement of all that follows. Uniform attention to these details at the start will soon make their observance easy and habitual; and the general moral effect of punctiliousness in this department of mere form is a matter

not likely to be overestimated in its bearing upon every aspect of composition.

Illustrations

Function of the Sketch

The teacher, as Professor Laurie of Edinburgh never ceased to reiterate, should ever "present to sense." We respond emotionally to what we hear; intellectually, to what we see. Nowhere is this advice more directly applicable than in the field of technical writing. The engineer is trilingual,—he speaks the language of words, the language of mathematics, and the language of graphical representation. Over and over again he finds occasion to supplement one of these by another. Thus to the aid of verbal description he will often call the illustration, the photograph, the sketch. Although the expense of it prevents the indiscriminate use of illustrations in articles destined for the press, economy of another sort often argues for their not inconsiderable admission. At any rate, we find entering as a factor in the problem of composition the articulating of the text with "plates" and "figures" and photographs—with drawings, pictorial, sectional, and schematic,—drawings that present subjects of discussion in their every aspect, all the way from their single isolable features to their general appearances on all three sides at once.

Such representation cannot fail to test the adequacy of our own conception of the thing regarding which we speak. We can make talk about matters while yet they are hazy in our minds; we can sketch in detail only such objects as in our thought have found specific form. This definiteness being the peculiar merit of pictorial representation, we desire our representations to be the most vivid possible. No dumb partial resemblance will satisfy us; nothing but a *speaking* likeness, and one that speaks the truth,—one in which every line and point is eloquent of some essential fact. Such graphical presentation will be, not a formal accompaniment merely, but a true supplement of the article with which it goes. Under certain circumstances, in fact, it will rise to a place of coordination with the written text; and

from there it may even go on to the point where the text has contracted to an explanatory paragraph, and then declined to a mere title.

Preparation for the Sketch

The former head involves the provision of materials and the taking of the steps that antecede the actual design. In the first place, if the drawing is to go well with the written composition it should be on paper of the same size —8½ by 11 in. This should be white, unlined, and of the weight of fairly heavy bond. When handed in it should be clean and smooth, save possibly for the middle crease. The appearance of the sheet is always improved by the presence of ample borders; so we carry a bounding line, either single or double, around the four sides, some ½ in. from the two sides, and ⅝ in. and 6/8 in. respectively from the top and bottom; or, if the sheet is used with its length horizontal, 6/8 in. from the sides and 4/8 in. and ⅝ in. respectively, from the top and bottom. The finished drawing should be traced in black india ink throughout, with the possible exception that dimension and reference arrows may be in red, the latter in this case being given black heads that they may appear more unmistakably in the final reproduction. Consideration should be given to the fact that a judicious varying of the weights of line both enhances the pictorial effect and contributes materially to the intelligibility of the drawing. The draftsman should give attention to the parts of the drawing; to their number and character and position; to the placement of any reference words accompanying the sketch; also, to that of the list of parts if it is to come within the boundaries of the drawing; and finally, to the position of such other inscriptions as the title and the signature.

Type

The character or type of illustration that best will serve depends of course on the character of the subject. That sort should be chosen which promises to convey the most immediate and vivid impression of the object portrayed,—

more particularly the notion of its shape and size. The leaning in such sketches as we have occasion to make is generally away from the working drawing with its extreme elaboration, and toward such forms of representation as are more characteristically pictorial and diagrammatic. Our object in the main is not to provide an apparatus for the construction of the thing represented, but rather to present it in such a way as will lead to its better understanding. Accordingly, any of the recognized forms of graphical reproduction will serve us, either perspective, or isometric drawing, cabinet drawing, or orthographic projection. In one case an assembly of the object may best suit our needs; in another case, the presentation of the object in a sectional or a half-sectional view. Here, plan and elevation will be required; there a general view with supplementary details; again, a showing of the object with its moving parts in different positions. In every case, however, the draftsman should give one thing *or* another; in his representation of the essentials as these are brought out in the body of the paper, he should carry everything out with due regard for the recognized conventions of drafting practice.

Arrangement

In arranging the drawing on the sheet, the draftsman will make tentative sketches to determine the size that, without overcrowding, will best occupy the space available. Other blockings out of the figure, or figures, and of the legend, may similarly be made for the purpose of determining the most effective apportionment of the space at hand, to the end that no suggestion should appear either of waste or of congestion. Single figures should be well centered, and squared with the edges of the paper; combinations of figures should present a pleasing sense of symmetry and equilibrium. As a rule, the space actually occupied by the drawing and the legend on an 8½ by 11 in. sheet is about 5½ by 7 in.

In his inclusion of details his first and last effort should be to retain as much of the significant as is compatible with the avoidance of all confusion. The proper representing of

lines, broken, centered, and shaded; and of the conventional symbols for such features as wood, glass, iron, fluid, flame, electrical parts, etc., should receive his scrupulous attention. Overall dimensions and indications of any variation of the scale from figure to figure he should invariably enter on the sheet. In the writing-in of dimensions on the sketch, he may use the signs for feet and inches ($1' — 1''$), a usage consistently avoided on the printed page.

Supplementary Considerations

References

The matter of references opens up a wide field for consideration. Regarding the usefulness of reference devices, we can make no question. The silent, "orphaned" drawing without symbol and without inscription falls very low in its percentage of possible effectiveness. The only problem, accordingly, relates to their form and character, not to the matter as to whether or not they shall be used. In the first place, they should in every case be shown in formal lettering, —no script whatever being entered on the drawing sheet. Moreover, to the size and weight of line used in such lettering judicious attention should be given. Sizes should be uniform, or carefully graduated; the arrangement should be orderly and conspicuous; and, wherever possible, figures and letters should appear upright on the page. In cases where ample spaces are available for the purpose and the parts are few, the names of structural features are most reasonably entered directly on the pictured parts. Where, on the other hand, because of the restriction of space or the complexity of a figure, such placement of names is impracticable, and where at the same time the number of parts is not excessive, reference arrows with their fine points accurately indicating the part to be identified may be brought out to words of identification written at the side. These arrows (not feathered or half-feathered, by the way, as are the arrows showing direction or current flow) should be either straight or else bent at uniform angles, or with uniform graduation, so as to give in their totality the effect of a definite system. The words to which they lead should also

present some regularity of alignment. An attractive effect is secured, where the arrows come away from the figure at a slant, by turning them (either outward or inward) back to the horizontal when they reach the word line, and there carrying them under the terms to which they severally correspond.

But, to take still another case, where the character of the figure scarcely permits the entering of full words about its sides, the draftsman has recourse to still other methods of referencing. He may enter letters directly on the parts as they are shown, or he can lead out arrows as before from these parts to letters aligning on the outside. In cases where the details to be pointed out run over twenty-six, arabic figures may be substituted in their place; but, as a rule, literal reference where it will serve is given marked preference over the figurative. These letters or figures should be large enough to be distinctly visible, and, so far as is at all practicable, they should progress with regularity. To place them within small circles adds considerably to the general appearance of the drawing. From such letters or figures reference is provided to a tabulated list of parts called the "legend." This is entered wherever circumstances permit, if possible, at the lower sides; or, failing this, in equal columns at the bottom of the sheet. Where, however, the inclusion of the legend in the figure would result in crowding or confusion, it should be placed below the drawing in the body of the text. Reference words should be in lower-case letters with initial capitals: in the legend they should be separated from their reference symbols by a dash, and should not take any following period. Reference letters are almost invariably capitals. The indicating of those groups of parts that belong together either by spacing or by headings, contributes not a little to the ease with which a complicated figure can be mastered.

Inscriptions

The inscriptions on the drawing consist, first, of a title lettered in full capitals, appropriate in style and appropriate in size. This may well be centered at the bottom of the

page just below the border line. Note that in plans and working drawings the title is placed in the lower left-hand corner just within the border line. If more than one illustration appear, and if the figures on each are single, each title is prefixed by the abbreviation "Fig." followed by a period and a dash. If any sheet contains more than a single view of the object portrayed, then it may be termed a "plate" (numbered with a roman numeral) and each subordinate representation a "figure." In this case the abbreviation "Fig. 1. —," "Fig. 2. —," etc., together with a brief descriptive title in small capitals (with no following period), is placed under each of the minor representations. The signature of the draftsman (surname followed by initials) is placed in the lower right-hand corner just within the border; and immediately following this is entered the date.

Symbols in text

All that remains is to say a word regarding the showing of reference symbols in the text. Here figures, capitals, and lower-case letters, if these are used, all appear in italics (indicated in the manuscript by single underscoring). This device so effectually separates them from the rest of the text that the use of commas or parentheses for this purpose is unnecessary. The use of parentheses is particularly undesirable because of the possible confusion of this use with that of tabulation symbols in continuous written matter.

Figures in text

Where incidental figures occur in the text, they should be allowed plenty of room, as any crowding in of the text upon them or their accompanying legend is sure to detract materially from effectiveness of presentation. Seldom should they be accorded less than half the width of the page with ample spaces above and below. To allow the full width of the page is, in manuscript, almost certain to enhance their value as illustrations. Particularly where lined paper is used, the making of the sketch on another sheet and pasting it in is to be recommended. The position in the text

and the manner of manipulation, should be freely used to supplement the verbal text. Notes, also, may well be frequent and explicit.

"How" is always a greater word than "what"; yet to *tell* what to do, strange to say, is all but universally accounted more difficult than to do a thing one's self. In directions writing, which, it may be observed, is but specification writing on a lower scale, the price of success is "eternal vigilance and invincible determination." The writer in this form takes upon himself the burden of tacitly guaranteeing a satisfactory outcome to whoever scrupulously does as he prescribes, does this and does no more. Accordingly, he must analyze every familiar operation, especially the one whose performance is to him well-nigh second nature, and mark carefully its every step. This implies powers of visualization, and powers of kinesthetic memory. He must anticipate every possible contingency; and, what is more, he must provide for it.

Particularly in references to apparatus should the directions writer specify exactly and completely. Not all surveying jobs have the same requirements as regards necessary equipment. One piece of work calls for a transit: another, for a level. Now the party requires a leveling rod or a ranging pole; again, an elevation rod or a stadia board;—in one case, a particular sort of pole, in another, a special target or some special type of scale or vernier. Ordinarily the operator will not require a thermometer or turnbuckles, a spring balance or a magnifying glass,—but again he will; not always will ax or hatchet, special stakes or pins, nails or tacks or brads be essential; but on some particular piece of work they will be all but indispensable, and in such cases the necessity of their provision should have been foreseen. The directions writer must throughout look painstakingly to the integration and representation of all his facts. No mean undertaking, is this, in its entirety; no mean test of a man's ability. The man, however, who in college can write such directions as nowhere leave performance in the lurch, can be counted upon in later life to draw up a set of specifications that will be reasonably proof against quibbling and litigation.

All this means that, in directions, members—particularly those dealing with the manner of performance—must be much more full and explicit than were those that sufficed for exposition. Such statements as the following will in the case of directions never do:

take necessary data at different loads
set the blade to cut at a moderate rate
ram the material to the desired hardness
dry the material in a hot oven.

Incidentally, in directions writing the beginner should learn to introduce freely the terminology proper to the technique with which he is occupied, for example, to such terms as "smoothing or 'surfacing' the plates on both sides," in machine shop parlance; to "quenching," in that of the foundry; to "wiping" a lead joint, in the language of the plumber; or to making a "wiping contact," in that of the electrician.

The skeleton outline used in the Introduction of the expository paper (p. 19) will serve eually well for this subject of directions, providing that the schedule of materials and implements is supplemented with such detail as is necessary for surety in their selection. The outline that we shall follow in the Body of this directions paper may conveniently employ the phraseology and arrangement that appear below.

BODY. (Directions for doing the work.)

.... ing . . [*supply a verbal noun and its object*], then, is a ...... [*supply the proper number*] -stage process.

A. The first stage is to ... .. the .... . [*supply an infinitive and its object; and add any necessary adverbial modifier, telling how, where, etc., the work here mentioned must be done*]. To ...... the ......, proceed as follows:

I. ...... the ...... [*supply a verb in the imperative with its object, and add any desirable modifier*], to perform which operation take these steps:

1. ...... the ... . [*supply a verb in the imperative, its object, and any adverbial modifier or modifiers that may be essential to full adequacy of specification,* (*or, the semicolon*)]
2. ...... the ...... (*or, possibly in short topics, the pronoun* it) [*supply as in 1, above*], and

3. . . . . . the . . . . . . [*supply as in the foregoing*], which is done by
    a. . . . . .ing the . . . . . ., and
    b. . . . . . .ing the . . . . . .; then, after the . . . . . .ing of the. . . . . . [*supply modifier if necessary*] has been. . . . . . [*supply* effected, accomplished, brought about, etc.]

II. . . . . . . the . . . . . [*supply as in I, above*], to perform which operation take these steps:
1. . the . . . [*supply as before*], and
2. . . the . . . . . .; and then, after the . . . . .ing of the . . . . [*modifier?*] has . . . .,

III. . . . . . . the . . . [*continue as before*].

B. After . . . . .ing the . . . . . . [*i.e., finishing the work in stage I*], go on to the . . . . . . [*supply* "second," "next," "final," *etc.*] stage, namely, to . . . . . . the . . . . . . [*supply an infinitive, its object and possibly a modifier*]. To . . . . . . the . . . . . ., proceed as follows: [*continue as in A, and so on to the end.*]

As an example of what may be held to be a reasonable degree of completeness in such exercises as this, we give the following directions bearing on the heat treatment of a chisel.

To heat-treat the chisel proceed as follows:

I. heat the chisel in a forge fire, in carrying out which operation take these steps:
1. bring the fire to a point where it is
    y. red, and
    z. free from smoke;

    Note 1.—For such work as we describe, the ideal fuel is coke made on the forge.

    Note 2.—Another method of heating the chisel, however, and one more generally used in large industrial plants, is to heat the chisels in a bath of hot lead.
2. place the cutting end well in the fire, but in such a way as to subject not over two inches of its length to the direct heat;
3. cover the chisel with well-charred fuel to prevent the formation upon it of heavy scale;
4. raise its temperature slowly and evenly to the "critical point," or point of decalescence, which is done by
    a. warming the steel through at first without the use of the blast;
    b. heating it afterwards somewhat more rapidly under a very light blast, taking constant care lest the

temperature of the cutting edge reach a point higher than that of the heavier part of the wedge immediately above it,

c. turning the piece regularly the while, in order that the heat may penetrate uniformly to every part, and

d. noting the advance of color to the cherry red, which marks the desired, "critical" point of temperature (approximately 1475 deg. F.),—making these observations, moreover, with the least possible removing of the steel from the fire; then, after the heating of the chisel to the correct temperature has been effected,

II. harden, or "temper," the steel, in carrying out which operation take these steps:

1. remove the chisel from the fire, with a pair of tongs holding it firmly in a vertical position, and keeping the cutting edge downwards;

2. "quench" the steel by momentarily immersing about half the heated length of the chisel in water, using a slow, gradual unhurried but unhesitating movement from the very moment it breaks the surface until it leaves the surface again;

   Note 3.—Permitting the steel to remain stationary at any instant while it is in the bath causes in it a "water check," or line demarcation, along which line fractures are particularly liable to develop.

   Note 4.—By using, instead of the water bath, a bath of brine, a greater degree of hardness may be obtained in the steel; and by using a bath of oil, a less degree of hardness.

   Note 5.—If in the hardening of the chisel the quenching movement is too rapid, the steel will not cool through, and a jumble of colors will result; if the movement, on the other hand, is too slow, the heat will be insufficient to temper the steel, and no colors will appear.

3. rub away the scale as quickly as possible from one flat side, using an emery stick, rough sandpaper, or some other abrasive, so as to reveal the tempering color;

   Note 6.—If this step is not carried out with dispatch, the operator will be unprepared for the moment of final quenching, i.e., he will "pass the colors," and in this case the operation must be repeated from the beginning.

4. hold the chisel vertically as before, in a suitable light, and close down over the bath, watching attentively the cooling downwards of the steel along the polished surface, through successive tints of pale yel-

low, light straw, dark straw, brown, purple, pigeon blue, and light blue;

Note 7.—Steel quenched finally at the dark straw color is suitable for work on stone and concrete; that quenched at the moment it shows purple, for work on soft steel; and that allowed to reach the stage of pigeon blue, for work on wrought iron.

5. cool off the chisel the instant the desired color reaches the cutting edge by plunging it completely under the water.

Note 8.—Inasmuch as this entire operation of tempering occupies but a few seconds, alertness of mind and deftness of hand are major factors contributing to success.

In directions writing, just as in expository writing, care must be exercised to prevent a running together of steps that should be separate, as for example in the following:

To place the stock in the lathe proceed as follows:

tighten the hand wheel until the teeth of the spur are embedded in the wood and then loosen it until all tensity of pressure has been relieved;

or again, in the following:

turn on the live steam, being sure that all outlet valves are closed and so adjusting the inlet valves that the rise of temperature from about 100 deg. F. to the desired temperature will take about ten minutes. This is to avoid the uneven heating of the rubber.

The last part requires to be recast into some such form as,

turn on the live steam, to perform which operation take these steps:

1. Examine the outlet valves to make sure that they are so adjusted as to allow a rise of temperature, graduated through a period of about ten minutes (to avoid uneven heating of the rubber)
   y. from about 100 deg. F.
   z. to about 220 deg. F.

The natural increase in point of explicitness at critical points is illustrated in the following clauses:

To shape the chisel proceed as follows:

I. remove it from the forge with the tongs, maintaining a firm grip on the handles,

II. place its heated end on the anvil, holding the piece at an angle of perhaps 60 deg., as is shown in Fig. 2,

III. hammer the end into the shape shown in Fig. 3, to perform which operation take these steps:

1. apply fairly heavy blows to one side,
2. turn the piece over,
3. apply blows similarly to this opposite side, and
4. finish off with lighter blows applied on both sides, so as to obtain a smooth surface.

Note.—Before the proper shape is obtained, several re-heatings and re-hammerings may be necessary.

Occasionally one comes upon a process which requires working out through four or five degrees of subordination, such as appear in the following:

III. Examine the sand for moisture, to perform which operation take these steps.

1. squeeze a few handfuls from different places on the pile,
2. observe, upon opening the hand again,
    - y. whether the imprint of the fingers still remains, in which case the sand is wet enough,
    - z. whether the hand itself appears wet, in which case the sand is too wet;
3. proceed according to these determinations, which is done by
    - a. going on to the next stage, if the sand is properly tempered; or
    - b. effecting a proper tempering if this is not the case by
        - a′. adding more sand, or
        - b′. adding more water.

Note that in this outline each "stage" begins a sentence; each "substage" is introduced by the words "proceed as follows" and a roman numeral; each group of "steps" by "take these steps" and an arabic figure; each "substep"—departing from the imperative to avoid confusion, by "which is done by" and a lower-case letter; after which point any other suitable transition can be made to serve.

The writer here, as in the explanation of a process, must be on guard not to involve himself in difficulties by taking as a main topic some act that is elementary and indivisible; such, for example, as "shave" or "bolt," for the reason, first, that in themselves these do not constitute main steps of any considerable operation; and second, that beyond them nothing else remains to say. To "cut," on the other hand, or to "join," involves not only the action itself but the providing of instruments, and possibly also of devices for holding the work during the operation. The important thing is to tell just what is done, and then how this is effected.

CHAPTER IV

PUNCTUATION

A simple
and straightforward sentence
requires no punctuation
save at the close.

As the sentence departs, however, from this singleness and simplicity, punctuation enters, first as a convenience and then as a necessity. Here the comma, semicolon, and other marks convey meaning even as do the words themselves, taking the place in written discourse of the pauses, intonations, and stresses of conversation.

The relations expressed by punctuation are by no means difficult of comprehension. Those indicated by the terminal marks are especially simple. The other relations may be classified according to their deviation from regular form. In general, punctuation is used to mark beginnings or endings; to indicate integral units or sentence movement; or to suggest some one of the voice signals that serve us in speaking. Do we drop out a sentence element, or introduce extraneous matter, or shift material from its normal position, or reproduce some logical unit, this fact is signaled to the reader by this device of punctuation. Its use is partly a matter of rule, but partly also a matter of feeling. To give any single rule for many an effect is well-nigh impossible, hence a classification of this subject can scarcely be strict and scientific. The parenthetical may serve for transition, and emphasis may arise from ellipsis. Despite this difficulty, however, we shall attempt a partial classification, hoping that it may prove useful for purposes of review. To find and make examples for each head that is here listed can scarcely fail to work improvement in this department of composition.

Terminal uses.

A. For marking beginnings.

I. Formal introductions of enumerations, etc.

1. With introductory word (*as follows:*), etc. (a colon).
2. Without introductory word (*are of two general types: is divided into four classes: Two cases must be distinguished:* etc.) (a colon).

II. Semi-formal introduction by *namely, i.e., for example, e.g., first,* etc.

1. These connectives may begin a sentence.
2. They may be preceded by a comma and followed by a colon.
3. They may be set off by two commas.
4. More frequent than the preceding, however, is the placing of a semicolon before these connectives, and a comma after them in continuous text; or a colon, when the following material is paragraphed.

III. Quite informal introduction.

1. Figures within parentheses (*1*), (*2*), etc., before the several heads.
2. A dash, suggesting the quick bringing in of an appositive with a suggestion of a raising of the voice (*This can be summed up in one word—Interchangeability; What marvelous inventions—the radio, the vitaphone, television!*) Also, introducing a summarizing word (*glass, enamel, ivory, porcelain —all these have been*).

B. For marking endings.

I. Uninflectional.

1. Declarative sentences (a period).
2. Imperative sentences (a period).
3. A long subject, especially if involved (a comma).

II. Inflectional.

1. Interrogations (a question mark).
   a. True questions.
   b. Questions of effect.
   c. Rhetorical questions.
   d. Successive questions.
   e. Complementary questions (*The question rises, What callings can we call professional? Someone may ask us what is to become of this present system?*)
   f. Notes of doubt (a question mark within parentheses, e.g., on *June 17* (*?*), *1788*).

2. Exclamations (an exclamation mark).
   a. Vivid, forceful expressions.
   b. Expressions of surprise and doubt.
   c. Expressions of strong emotion.
   d. Expressions of peculiar interest.
   e. Interjectional expressions.
   f. Certain sentences ejaculated in the interrogative form (*How much better the old way!* *And what if this continued!*).

Medial uses.

A. For indicating the identity of members.

I. Terms (quotation marks).

1. Letters, symbols, or technical designations occurring in text (*shall be lettered "A," "B," "C," etc.,*).
2. Technical significations (*the "penny" system of referring to nail sizes;* *commonly called "drying"*).
3. Irregular locutions such as slang or unfamiliar idiom (*how the employees "put one over" on the company;* *this "what odds does it make?" attitude of mind.* Note that the last modifier might be connected throughout by hyphens; cf., *a take-it-or-leave-it attitude*).

II. Quotations.

1. Indirect quotations, embodying the substance, but not the exact words, of a speaker's remarks, are not set off by quotation marks.
2. Direct quotations are inclosed in quotation marks.
3. Quotations within quotations are inclosed by single quotation marks; and quotations within them again, by double. Note that a simple rule and one generally followed places *all* commas and periods within—that is, *before*—quotation marks, and places semi-colons and marks of exclamation and interrogation either within or without as logic demands. When quoted matter extends continuously beyond the first paragraph to a second or later paragraph, quotation marks are placed at the beginning of each paragraph, and at the end of the entire quotation, but not at the ends of any quoted paragraph except the last.

B. For indicating the structure of sentences.

I. Single independent clauses and their adjuncts.

1. Omission, or ellipsis.
   a. A word, or words, readily supplied (a comma).
   b. A section omitted from a quotation (three dots; or four dots, if it overruns a period).

2. Insertion, or parenthesis.

   a. Extraneous matter (commas, parentheses, dashes).
   b. Transitional words, incidental "sentence adverbs," phrases of reference and relation (commas).
   c. Appositives, members of equivalence (commas, parentheses).
   d. Explanatory modification, qualification,—either participial phrases or non-restrictive relative clauses (commas, parentheses).

      Note that limiting, or restrictive, phrases or clauses do not require to be set off by punctuation.

   e. Independent members.

      a′. The "absolute" participial construction (commas).
      b′. Sentence inserts (parentheses, dashes).

3. Transposition.

   A sentence element, say a modifier, when shifted from its normal position immediately after its antecedent, is regularly set off by a comma or commas; save in very simple sentences, and in the case of introductory phrases followed by a verb, or a pronoun, or the expression "there is" (one, by the way, which the author hopes he has nowhere used in this book).

   a. Adjective clause modifier;
   b. Condition;
   c. Concession;
   d. Cause;
   e. Degree;
   f. Exception;
   g. Means or method;
   h. Purpose;
   i. Place;
   j. Time.

4. Coordination, parallelism, series. Two or more elements of like construction and logical relationship, when they are connected throughout by *and's* or *or's*, require no punctuation; when, however, this connective is omitted, as it usually is between all the members but the last two, commas should be used between all the items, including the last two joined by the *and*.

   a. Series of simple coordinate facts, operations, etc.
   b. Series containing compound units.

c. Series containing units punctuated within themselves.
d. Two or more "coordinate," equivalent adjectives (*a fine, silky, uniform fracture; a clean, sharp thread.* Cf. *a hard steel tamping bar, a red hollow iron cylinder, tall steel-skeleton office buildings*).
e. Two or more expressions joined by the coordinating, appositional *or* (*a breast wall, or face wall; rough edge, or flitch.* Cf. the non-coordinating, alternative *or*, seen in a *galvanized-iron or tin pan, a shovel or a spade, a tup weighing 1500 or 2000 lb., these roller or swing bearings*).

Note that *or*-phrases of greater length are often set off by commas because of their suggestion of something parenthetical.
f. Catalogued items formally introduced (commas or semicolons).

II. Conjoined independent clauses and their adjuncts (comma, semicolon, colon, dash). The punctuation of these sentences depends partly upon the nature of the conjunction used—or upon the absence of a conjunction, and partly upon the relation of the elements that are compounded.

1. Connection by a simple conjunction (*and, but, yet, or, nor, for, while*).

a. Where the clauses are short and direct, no punctuation may be required.
b. Normally, however, the comma is used to join the parts of sentences of this type.
c. Some special considerations such as the length of the parts, the presence of punctuation within the parts, or the desire for antithesis or emphasis, may lead to the use in sentences of this type of the semicolon.
d. To suggest an abrupt change of thought, or interruption of the thought, the dash is used.

2. Connection by a conjunctive adverb, or "sentence adverb" (*accordingly, because, besides, consequently, furthermore, hence, moreover, nevertheless, otherwise, still, therefore, thus, as a result,* etc.).

a. The usual mark before these conjunctions is a semicolon.
b. Occasionally, in simple sentences, commas are found sufficient; also, commas may be used for some special effect.

3. **Connection without a conjunction.**
   a. **The regular mark in this case is a semicolon.**
   b. **In case, however, the sense of the first member is virtually repeated in the second, or in case the rhetorical opposition of the two is a matter especially to be stressed, the mark which best meets the requirements is doubtless the colon. The colon also suggests equivalence of meaning between two clauses.**
   c. To indicate a quick continuance or transition of thought, the dash proves most effective (*They so support each other—they are so perfectly complementary. We despaired of the dollars—we sought to save the cents.*).

Elsewhere we have discussed the hyphen and the apostrophe, and the square brackets used to inclose editorial comment.

Punctuation had its origin in the efforts of the Greeks to mark the movement of rhythmical sentences. The "period" was the "path" (Cf. an*ode,* cath*ode*) "around" (Cf. *peri*meter, *peri*phery) an idea (Latin *circuitum*); hence, the name for the mark at the end of a sentence. A desire to keep the sentence in balance led to its division into two parts,—a "limb," or "colon" (Latin *membrum*) being imagined on each side; and finally, a desire for a knee or elbow joint in this limb, led to its "cutting" by the "comma" (Latin *incisum*).

Thus do these "stops," as once they were called,
  suggest the pauses of all perfect sentences.
The student will do wisely who restrains his sentences
  within the limits of this ancient rule.
The more simple his periods, the less the danger,—
  the fewer the situations which he cannot punctuate.

Some may detect in these short sentences the alternating and "ambulatory" movement of all rhythmical utterance. Rhythm is nothing else than measured, ordered thought; and punctuation is at once a promoter and indicator of this order.

CHAPTER V

THE APPARATUS PAPER

(Technical Description)

Introduction. The material for presentation.

A. Man, "a tool-using animal."

- I. His instinct for indirect achievement.
  1. By the use of tools.
  2. By the utilization of natural forces.
- II. His desire to augment his natural ability.
  1. By the supplementing of the skill and strength of his hands.
  2. By the supplementing of the sight of his eyes.

B. The media of his artifice.

- I. Simple forms.
  1. Tools.
  2. Instruments.
- II. Complex forms.
  1. Apparatus.
  2. Machinery.

Body. The problem of presentation.

A. The subject matter.

- I. The unit elements.
  1. Concrete.
  2. Abstract.
- II. The variety of elements.
  1. Structural.
  2. Functional.

B. The technique of presentation.

I. General consideration.

1. Elements in isolation.

   a. The definition of items.
   b. The articulation of items.

2. Elements in combination.

   a. The handling of coordinates.
   b. The handling of complexities.

II. Particular considerations involved.

1. In presenting mechanical structure.

   a. The introduction.
   b. The body.
   c. The conclusion.

2. In presenting mechanical operation.

   a. Varieties encountered.
   b. Procedure followed.

CONCLUSION. The completing of the presentation.

A. Characteristics of the outline.
B. Characteristics of the finished article.

Thomas Carlyle speaks of man as a "tool-using animal"; and indeed man is distinguished from his lower kindred by his faculty of utilizing means quite outside his own complement of physical parts to effect his ends. In him, necessity breeds invention. Pondering his needs, he looks round about him, and in nature, static or in motion, he is pretty sure to see something that he can make shift to use for the accomplishment of his desires. From sticks and stones, he advances to the using of twisted thongs and simple fabrics, and once started in the way of fabrication, he is eager to utilize every natural agency, and every ability of the lesser animals and even of the lower orders of his fellow men. Thus he goes on from elaboration to elaboration, drafting all the elements, and in time mechanizing the world.

Man's Desire to Augment His Natural Ability

Now man is urged to these devices by his strong sense of limitation. He wants, first, to augment his physical strength of body and limb,—to hold with the grip of a giant, to move with the power of the sea; to twist and bend and rend; to strike and cut down and destroy. In the second place, he desires to supplement his perceptional faculties. He desires greater accuracy than his unaided sense can give him,—graduations more subtle, proportions more exact. He wants to know position and to know it precisely; to measure distances and amounts, and to gage them to a hair. And so spurred on from each acquisition to the one beyond, he makes of his yardstick a steel tape, of his spyglass a solar reflector and the marvelous mechanism of television; his steelyard evolves into the analytical balance, and his first rude abacus into calculating machines with powers of performance ever more and more astounding. In the end his tools and instruments and apparatus and machinery all but live and think. In the thought of the poet they actually bridge the gap, and as Robots, become a race of destroyers that set at naught the petty might of their creator.

The Media of Man's Artifice

Man's "tools" are at first simple in structure, and indeed little more than extensions of his hands. With them he works directly on material in a manner which may be carefully particular, but not minutely and meticulously exact. When, at last, special refinement is required, the Saxon "tool" becomes the Latin "instrument," by which term we understand a mechanical device, still operated, it may be, by hand, but wrought out with greater subtlety and complexity, and most accurately adjusted in its several parts. When such an instrument advances in complexity to the point where it loses its simple unity of design, we begin to refer to it as an "apparatus," using here a term also applicable to a collection of implements serving as equipment in some particular line of performance. And so with the development of apparatus, we reach at last the conception of the "machine,"

at first simple as a nutcracker, in the end all but organic in the interaction of its related and mutually dependent parts. We find direct bodily force and motion magnified by the application of mechanical laws; we find these laws operating as it were of themselves in contrivances all the way from the waterwheel and the hourglass to the thermometer and anemometer; and once man has unlocked the secrets of elasticity and expansion, power-driven "machinery," alone and in intricate successions and assemblages,—pneumatic, hydraulic, steam, gas, electric,—takes over the burden of his work.

The Problem of Presentation

Now a common quality of all these devices of man, from his simplest implements and utensils up through the most elaborate fabrics of interlinked design, is structure. They are all phenomena existent in space, and, as such, things to be described, just as existences in the other great category, time, are things to be narrated. If the object we wish to describe is single in its nature, as is a carpenter's square, a clawbar, or an anvil, we present it in terms of size, weight, and material, and by reference to its shape, to the position and conformation of its parts. To a large extent this sort of description makes use of adjectives and not of nouns. If, however, the object of our description is complicated in its nature, that is, composed of a less or greater number of constituent members, then our work of description consists of relating these parts to one another, of resolving them through nominal groups and subgroups to that singleness of structure that can be treated as before.

But description is not all; behind description, exposition ever waits. In the lower ranges of utile contrivances, the "operation" is wholly in the arm or foot that presses, strikes, or twists; but with the introduction of parts that are mutually resistent, things happen that need to be explained. From surprise at what takes place, we go on to wonder, and in the end stand speechless before what seems an unseen flow of intelligence, streams of living action that manifest themselves in marvelous concatenations and complexes of causes and effects. We ask how? and why?—we demand a

reason; and the answer calls for another sort of composition, the explaining and expounding of these things unseen. On one level we stop at the prime mover,—it stands harnessed before us, or its action from a distance is made plain; but on another level we search deeper in our questioning, and require an answer to a more baffled—*Why?* We would know by what ultimate force the things before us came about,—by the discovery of what secret, mechanical or chemical, the effects were secured; by what knowledge of natural law the power in nature was confined, was liberated only thus and so, and thus constrained to work man's will.

In such study of the habits and behavior of natural force, we are concerned with what we may call the "principle" of operation, or the "theory" of design. Exposition has here advanced from the merest picture writing into its own proper realm of all but abstract thought where, in the arcanum of intelligence, reason is crowned and sits enthroned.

We have but to pass in review the names assigned to the parts of man's tools and mechanical contrivances to realize the extent to which they are but supplementary to his bodily functions. How are they named? In one or another of them we come upon,

> **the head, face, eye, iris, nose, mouth, lip, jaws, tongue, teeth, throat, neck, body, ribs, waist, back, shoulder, arm, forearm (rifle), wrist, hand, finger, elbow, knuckle, joints, legs, knee, feet, heel, sole, skin, skeleton,**

and not a few more; and along with these bodily parts such representations of man's garments as,

> **cap, bonnet, collar, tie, coat—over and under, in fact,—jacket, sleeve, button, pocket, belt, skirt, apron, shoe,—**

and in the word "truss," a term cognate not only with his "trousers," but with his wife's entire "trousseau." Male and female they are indeed; and animal as well as human, as such words as "shells" and "scales," and "horns" and "tails" amply attest, creatures that "run" and "kick" and "clutch," and require to be "fed." Still, in the main, they are human in their nomenclature rather than animal. "Fins" and "feathers" rarely occur. Originally, it is clear, man did his work himself. His "dogs" might hold it; and his

"horse" or "easel" might carry it for him, bearing it on a "saddle" or dragging it by a "yoke," but the manipulation itself was not theirs. And still as he works in factory or shop, he glances up to see at hand his earliest servitors, the "donkey" engine, "bull" pump, "calf" wheel, "hog" chain, "horse" dam, "mule" pulley, "pig" iron, then starts and grasps his hammer a little tighter to see just beyond them the "fox" bolt, "monkey" wrench, and "grizzly" screen. In the stream beyond are the "alligator" wrench, "fish" torpedo, "clamshell" shovel, "salmon" brick, and "turtle" deck; far overhead and round about he sees and hears the "crane" bridge, the "spider" frame, the "worm" gear, and the "grasshopper" engine; and as he pauses to contemplate these things he witnesses right at hand on the side of the "beehive" oven the quite miraculous metamorphosis of a "caterpillar" tractor into a "butterfly" valve. Truly interesting in its cultural reminiscence is this vocabulary of the arts technical.

Here, as in the case of the process paper, we are interested in the elements—in what we may call the lowest factors, of structure. Without attempting anything approaching completeness we list a few of them, with a thought mainly to their comparison and differentiation.

Amorphous shapes.—piece, lug, prong, pawl, block, knob, knot, stud, hub, nut, lug, stock, core.

Elongated shapes.—peg, pin, plug, needle, wedge, beam, rod, pole, joist, girder, stake, stave, spoke, pier, shaft, strip, stack, stick, strut, stem, shaft, shank, spindle.

Flat shapes.—shim, slab, sheet, strip, plate, panel, lamina, film, diaphragm.

Round shapes.—ball, globe, sphere, disk, wheel, roller, reel, ring, screw, coil, spool, spiral, worm, armature, rotor, pinion.

Supports.—base, footing, support, foundation, bed, standard, frame, shears, bracket, brace, post, column, pillar, pilaster, buttress.

Containers.—pan, pot, bowl, jar, bottle, flask, basin, buckets, cup, pail, bulb, trough, colander, vessel, tank, case, keg, cage, chest, cask, drum, carton, container, shell, mold, magazine, holder, hopper, chamber, lining, housing, bushing, socket, kiln, oven, furnace, retort.

Confiners and connectors.—hook, catch, clutch, latch, clip, buckle, clamp, shackle, grip, handle, lock, fastener, bolt, line, strand, link, chord, string, thread, hair, strap, wire, rope, cable, tackle, chain, belt, band, filament, guy, winding, leads, loop, shunt, spring.

Conveyors.—pipe, tube, hose, flue, duct, spout, tuyere, nozzle, tap, chute, slide, funnel, tunnel, pipette, burette, siphon, drain, main,

canal, conduit, channel, manifold, passage, groove, runway, track, flume, skip, conveyor, sieve, screen, grate, riddle.
Controllers.—door, gate, clamp, hinge, trigger, sear, lever, swivel, ratchet, crank, pulley, piston, plunger, switch, valve, gears, brake, axle, sprocket, escapement, pivot, cam, lens, prism.

From such as these we might go on to such compounds as,

cutoff, cutout, intake, overflow, straightedge,

and the like; and beyond to such complex units as,

dial, vernier, governor, magnet, or electrode;

and to phrasal compounds like,

block and tackle, plug and feathers, ball and socket, rack and pinion,

and the like; and, through these, to machines in their entirety. The fact that any adequate explanation of a structure will resolve it into such parts as these is the main point to be grasped. Incidentally the derivation is interesting, giving as it does a clue to the age of the conception among English-speaking peoples; and also possibly worthy of remark in passing is the fact that, in our work of reducing this modern machinery into its elements, we proceed in the main from words of classical derivation back to those of English.

But along with the parts—as *part* actually of the mechanism, are intervals of nothingness, each of which should be designated by its proper name, as for instance,

hole, gap, space, void, opening, bubble, orifice, cavity, notch, slit, slot, socket, groove, eye, keyseat, suction, and vacuum.

As to what constitutes structure, some question may now and then arise. Regarding specific object parts, we have no doubt. Regarding the propriety of calling necessary vacuums or tensions, orifices, or tapered holes, integral parts of structure, or again, of referring to such liquid contents as an electrolyte or "a small amount of mercury," as proper items of construction, we may have a reasonable doubt, and may have to exercise considerable judgment.

When specific words fail us in description, we freely make use of such abstractly descriptive expressions as we

have in the word *structure* itself, and in the italicized words in the following phrases:

the upper *motion*	a *set* of wheels
the motive *system*	a *system* of gearing
the barrel *assembly*	a *source* of power

the swinging *part*	a *means* of attachment
the middle *section*	a *device* for registering
the marking *element*	a *contrivance* for knotting
the stationary *member*	an *apparatus* by which—
the driving *mechanism*	(Cf. *provision* for handling)

Finally, to anticipate only one more mistake, "materials" are not parts,—in such a sentence, for example, as "The body consists of *boxwood,* covered with *celluloid,* and inlaid with *xylonite.*"

Simply to name a part by one common noun is not enough to insure a full realization of what is meant by it. If one refers, for instance, to a "screw," who is to visualize either its size, material, or character? It may be an external or an internal screw; it may be a "cap," "collar," "flathead," "dowel," or "capstan" screw; it may be a "tangent" screw, a "leveling" screw, or a "drive" or "slow-motion" or "micrometer" screw; it may be a "coach screw"—it may be a "thumb screw"—it may be a "set," "clamp," "lag," "tangent," "binding," "leveling," "adjusting," "tightening," or "locking" screw. And here we have not mentioned at all its wide range of possible material.

To refer simply to some generalized name of material may prove equally inadequate in explanation. The adaptability of the many kinds of steel, for example, being no less various than the names. This fact will appear if one checks over the accompanying list and notes the number of substances mentioned there that exist in different "kinds":

mineral, metal, wood, glass, clay, composition, rubber, porcelain, enamel, paint, quartz, agate, sand, mica, iron, brass, bronze, copper, nickel, zinc, aluminum, platinum, alloy, fiber, pulp, veneer, gold-leaf, inlay, bone, ivory, celluloid, carbon, varnish, shellac, japan, lacquer, oil.

We should also use the correct work in every reference to the *parts* of things; for instance, to the

tip, point, apex, vertex, side, rim, face, surface, front, top, crown, crest, bottom, base, rear, reverse, edge, bezel, rim, flange, middle, center, periphery;

and to the *shape*:

square, hexagonal, rectangular, polygonal, conical, cylindrical, circular, spherical, oval, elliptical, helical, spiral, deep, wide, thick, irregular;

and to the *constitution:*

solid, hollow, empty, heavy, fine, slender, stiff, coarse, firm, air-tight, permanent, stationary, steady, fixed, unmovable, rigid, tight.

Then we have *position,* expressed by such words as,

level, plumb, flush, parallel, perpendicular, vertical, opposite, tangent, oblique, inverted, inclined, slanting, sloping, transverse, peripheral, longitudinal, adjacent, adjoining, contiguous;

and to the *shaping:*

beveled, tapered, elongated, ruled, grooved, threaded, cross-hatched, criss-crossed, annular, knurled, laminated, serrated, corrugated, calibrated, graduated, pivoted, and insulated;

and such ideas of *motion* as appear in,

eccentric, centrifugal, rotary, revolving, rotating, vibratory, oscillatory, gyroscopic, springy, elastic, flexible, adjustable.

Finally, after checking the sufficiency of our reference to the material, shape, size, contour, volume, weight, or other significant characteristic of a thing, it may be our task to specify accessory or auxiliary parts with which it may be *equipped, furnished, fitted, provided,* or *supplied.*

The Technique of Presentation

Now these few notes, for all their own incompleteness, may suggest some little of all that is implied by completeness and sufficiency in any full acceptation of the word. Exact synonyms do not exist; general terms convey only ideas of vagueness; inexact terms breed only misinformation. Therefore, the person who would write well should first take pains to know his words, and after that he should study diligently to determine what words he needs. Much

better, in short, to describe a thing as a "linkage mechanism" than as a "thing-a-ma-jig."

To mention a part by name is not often to give an adequate description of it; a fact which becomes sufficiently apparent when we attempt to form mental images of such terms as *head, table, bed, frame, body, barrel, carriage, gearing, telescope, vernier, dial.* Again the mention of some general material, say "wood," may easily fall short of adequacy. We want to know whether the road drag is made of red cedar, red elm, or walnut, and whether the gin pole is best constructed of fir, pine, or oak, or *vice versa.* Thus it comes about that to be adequate the name of the part must often be supplemented by adjectival and phrasal modifiers descriptive of such characteristics. For example, we have,

number,—a pair, four.
color,—black, red.
size,—long, large.
shape,—slender, box-shaped.
condition,—rigid, strong, polished, truncated.
position,—vertical, slanting, revolving.
material,—hard rubber, phosphor bronze, galvanized iron.
appositional modifier,—a cap, or steel casting, fitting over the pole; the pawl pin, a small round piece of cold-rolled steel.
descriptive modifier,—scales from 1 to 10; a cylinder closed at both ends; a needle having a milled head at its upper extremity; a cast-iron frame 4 ft. high, by 2 ft. wide, by 3½ ft. long.
purpose,—a steel screw for tightening the lead; a pivot to provide means of rotation for the arm; a set of vanes to stir the water and so evenly distribute the heat throughout its volume.

The extent to which description may go is of course almost unlimited. Communication engineers can write at length on the initial development, or the middle, or the fading away, of the vowel sounds in such words, say, as *tāpe,* or *tōne.* If one sets about it one can find a surprising number of things to say about even so simple an object as a pencil lead, or a sheet of tin foil. With nouns we begin and proceed part way: with adjectives unmodified and modified, we complete our description.

When the single concrete member, which falls as a rule under an arabic numeral, has been sufficiently described, and referred to its pictured likeness in the drawing, the next

problem is to make the transition to the following head. The ease with which this can be done depends in no small measure on the judgment already used in separating the structure of the writing into main heads, and in beginning the description of this particular section of the structure with the proper head. Could we dogmatically assert that progress should always be from the base to the top or *vice versa,* or from the includer to the successively included or *vice versa,* our task would be vastly simplified, but to do this would in many cases work contrary to the mind's conception and readiest grasp of the thing described. As a general thing, the mind seizes first on some part that is particularly prominent or significant in the operation, and requires that we work up or down, or in or out or around, from it. Thus it follows that we must in each case determine our order on the basis of what we find. Progress, however, must in every case be logical, that is, it must follow naturally from one step to the step next adjoining. It must be couched, once more, in grammatical constructions which are the simplest possible; and due attention must be paid at each and every advance to verbal and phrasal parallelism in correspondent parts. Moreover, the presentation must be carried on in language which makes as clear as possible the relation borne by each successive part to the one before. To say that "the conveying apparatus consists of a pipe, a pipe rod, and certain couplings," is not, in our sense, to describe adequately. To link up the items by a succession of "and's" or "with's" or "which has's" is little better, and may easily through misstatement prove considerably worse. Similarly ineffective are statements that this or that "is," as for example, "next to which is," "at one end of which is," and "under which is,"—expressions which convey no suggestion of the manner of connection or articulation of one part with another.

Now the verbal form or phraseology of our transition will depend in part upon the degree of activity or passivity in the verb expressive of the relation between part and part. We have, in the first place, cases of assumed independence of behavior in the "major" part, if we may so term the one which incloses, or supports, or controls the other (or

"minor") part, which is held, supported or driven. Here we find such expressions as,

the——, which holds a ——
the——, holding a ——
the——, the center of which supports a ——

Here "which" refers to the major part, and the blank following the article *a,* the minor. Such progress from major to minor we shall call "forward." Besides *holds* and *supports,* we might generally substitute here such other words as *contains, incases, incloses, carries, moves, lifts, turns, draws, drives, compresses, locks, energizes, controls, operates, propels, protects, covers, reinforces.*

But along with these transitive verbs used alone, we have intransitive verbs used with prepositions similarly expressive of independence of behavior on the part of the minor term, —i.e., the one contained or supported by the other. As examples we may take,

the——, which rests upon a ——
the——, resting upon a ——'

Besides *rests* we may here usually substitute such verbs as *fits, hangs, stands, drops, radiates, slides, meshes, hinges, works, acts,* or *revolves,* used in conjunction with whatever preposition sense and idiom requires, e.g., *in, on, into, upon, over, about, between, against,* or *with.*

This type of progress from the minor term,—i.e., the thing contained or controlled, to the major term—the thing containing or controlling it, we may call progress "backward."

But now let us recur to the strongly transitive *hold*-clauses. The elements found in them may be inverted to the effecting of a reversal of sense equal to that of grammar. Let us write,

held in which is a —— (place)
in which is held a ——
held by which is a —— (instrument)
by which is held a ——
(a —— is held in (by) which
Note.—Cf. on the center of which is held a ——).

In these clauses the progress is observed to be "backward";

and similarly the *rest*-clauses are susceptible of transference from the original "backward" into a "forward" movement by making the *which* dependent upon the preposition, and by making the former object of the proposition the subject of the verb, thus,

upon which [major] rests a —— [minor]
(a —— rests upon which)
Note.—Cf. upon the end of which rest a ——.

But along with these verbs, suggesting assumed independent behavior on the part of the subject, come others which somewhat more naturally assume what we may call a semi-passive form. We can, it is true, speak of one member,

which connects, attaches, fastens, or links

to another, but more frequently we are drawn to the forms,

which is connected to, is attached to, is fastened to, *etc.*

Here, then, we have the forward progress seen in,

the ——, which is connected to a ——
the ——, connected to a ——;

and the corresponding backward movement seen in,

connected to which is a ——
to which is connected a ——
at the end of which is connected a ——
to the front of which is riveted a ——.

Similar verbs are *joined, coupled, linked, pivoted, screwed, soldered, mounted, built, equipped, furnished, provided, supplied,* and the like (some of which, by the way, are much more strongly restricted to the passive than are the others), used in conjunction with such prepositions as *in, on, from, with, into, over, upon, around,* etc.

Now we come to the full passive forms which on the whole are less frequently met than are the active and semi-passive; that is, the passive in major movements, where we may have passivity of form along with activity of sense. Generally speaking, the full passive calls for a *by* introductory to the means or agent or instrument effecting the action, thus,

the ——, which is held by (by means of) a ——,
the ——, held in place by a ——,
the ——, which is connected to the arm by a ——,
the ——, coupled to the feed pipe by a ——.

In passing, we note the difference between instrumental *by* seen in the expression "by means of rivets," and the process *by* seen in the similar expression "by means of welding," or it might be, "of pressure."

the ——, which is rested upon a ——
the ——, rested upon a ——
the ——, which is rested upon by a ——
the ——, rested upon by a ——.

Again, in passing, we note the equivalence between,

which fits into, and
    which is inclosed by;
which rests upon, and
    which is supported by; also
which hangs from, and
    which is suspended by;

and finally, its correspondency to what we have called logically if not grammatically the semi-passives,

which is connected by a ——, or
    connected by a ——.

Once more we note that in description we want only place relations, not causal relations: hence, the utter inappropriateness of the following:

C. The overload release comprises three parts:
    I. a solenoid, which has control over
    II. a plunger, which, when the current exceeds certain values, trips
    III. a trigger, which . . . .

Let us before leaving this subject emphasize the fact that the great secret of straight thinking lies in progress through a comparatively simple system of more or less generalized coordinates down to the actual. The great word here is "coordinates." Most people apparently have very indefinite ideas of what is implied by this word; they range motions with materials and parts with colors with never a thought that this can possibly be wrong.

"Com-position" is *putting* things *together,*—placing them together *exactly*. The most common and the most serious fault in composition lies in the failure, first, to perceive and then to express in language the similarity of relationship that exists in things. Composition is but the thinking out into language of such relationships. To add parts to materials and colors to motions is no less impossible in words than it is in mathematics. Yet still we continue to write,

> The body of the machine consists of
> 1. the frame made of
> 2. tool steel;

and to write,

> The core consists of
> 1. fine iron wires, used to eliminate
> 2. eddy currents, due to
> 3. an electric field, caused by
> 4. an electric current;

and once more to write,

> The lathe spindle consists among other things of another gear, which is fastened by
> 1. a key to the shaft, and is at
> 2. the right of the pulley, and thereby
> 3. turning the shaft, which has
> 4. a taper on the right end, into which
> 5. fits the live center, and around which fits
> 6. the dog.

In other cases, where parallelism is not at fault, the expression is often overdone, heavy, and awkward,—an illustration being;

> filling connections consisting of
> 1. a pipe nipple secured with a lock nut on the top, and
> 2. a pipe nipple secured with a lock nut and leather washers on the bottom of the box,

when we might expect

> pipe-nipple filling connections, consisting, on the top and bottom of the box respectively, of
> 1. a lock nut, and
> 2. a lock nut with leather washers.

Again the expression is often unnecessarily complicated by the misplacement of members, as in:

The straight-line mechanism consists of four parts,
1. a long arm, to which at one end
2. a short link is placed and a short distance from this
3. the link to the piston is fastened, while at the other end
4. a pencil is attached;

whereas logic and economy both argue for some such form as,

The straight-line mechanism consists of
1. a long link from the piston, connecting with
2. a short link to one end of
3. a long arm, to which arm at its other end is attached
4. a pencil.

We find frequent failure to begin with the significant part, and to indicate by a nice variation of connectives the differences in importance of the several members; thus,

I. a velocity recorder, which consist of
  1. a horizontal bearing which is connected by
  2. a water-tight gear housing, in which is contained
  3. the horizontal shaft gear, mounted in which is
  4. a bearing, running through which is
  5. a horizontal shaft, mounted upon which is
  6. a propeller; all of which are connected to

II. the sound-producing mechanism;

a case where better understanding would be insured by a reversing of the order and an introducing of subtle changes into the transitions:

I. the velocity-recording mechanism, consisting of
  1. a four-bladed propeller, mounted on
  2. a horizontal shaft running through
  3. a bearing into
  4. a water-tight gear housing where it connects with

II. the sound-producing mechanism.

The use of incidental parallelism is illustrated by:

The barrel consists of
1. a fourteen-sided regular polygonal shell
    y. 20 in. in length, and
    z. 28 in. in diameter, reinforced
        at the edges by

2. steel plates, and inclosed at the two ends by
3. gray cast-iron heads, between which extends
4. an iron partition dividing the barrel into two equal sections.

In outlining the body of this paper our chief concern is to secure simplicity along with some definiteness of relationship. Always we prefer the twofold division, even where this embraces the concrete details from two steps away in abstraction, as in,

The main part and
the secondary part.

Altogether acceptable divisions are such as these:

the fixed part and the movable part
the upper motion, and the lower motion,
the energy circuit, and the calibrating circuit
the pressure-measuring element, and the volume-measuring element
the upper or mechanical part, and the lower or stabilizing part.

Failing a twofold division, applicable to such instruments as a level head, a potentiometer, a steam indicator, or a current meter, we have recourse to a threefold division which often means the including of the base upon which the two mutually reacting members rest, as, the motions of the transit are supported by the tripod, or, the primary and secondary windings of the transformer upon the core. To be forced into some fivefold or ninefold main division is not to have solved the problem—either of limitation or of analysis. No sevenfold subject is as yet "thought out into clearness."

A word now regarding the conclusion. At this point we should have one form of instrument rather definitely before us. Comparatively little effort will extend this information to cover significant facts regarding other designs and types slightly differentiated from the one at hand; regarding their materials, structure, adjustments, graduations, power, capacity,—whatever, in short, may be significant about them. No sentence merely perfunctory will ever suffice to end our discussion: no empty gesture will serve our turn. In every case the thing communicated should be highly factual,—facts of interest; facts of importance. Always we must ask what facts are at the moment of most

significance. Those regarding degrees of accuracy? or adaptability? or practical sufficiency? or, regarding the ease of operation? And here reasons for advantages or limitations, may well supplement mere predication and bare assertion. But the first rule, once we have given indication that the conclusion is on its way, is to be brief and to the point.

With these preliminaries, we suggest an arrangement suitable for the outlining of a descriptive paper.

(*THE TITLE*)

INTRODUCTION. (Definition and division.) The character of the [*supply* device, instrument, apparatus, machine, *etc.*]

A. The ...... we may describe,

I. in a general way, as a ...... used

1. by

a. ...... [*supply word indicative of the users of the thing discussed*] and

b. . . . .,

2. in the process(es) of

a. . . ing [*supply, if necessary, an object*] and

b. ......ing [*supply as in* (a)]

3. for the more specific purpose of

a. . ....ing ...... [*supply an object; and if necessary, a modifier of the verbal*] and

b. .. . ing ...... [*supply as in* (a)]; or,

II. in a more exact manner we may describe it as a ...... [*supply* contrivance *or some other term properly expressive of its nature*]

1. constructed

a. of . ... [*supply materials term*], and

b. in the general shape and dimensions shown in the accompanying sketch:

Box to indicate the position of the sketch, which itself will appear on a separate sheet.

2. and composed of ...... [*supply number word*] main parts, namely,

a. ...... which ...... [*supply transitional words showing the relation specially of Part* (a) *to Part* (b)]

b. a ...... which [*supply as in* (a)]
c. a ......

B. The purpose of this paper is twofold; first,
I. to describe in some detail the structure of the ......, and then
II. to explain in a more general way its manner of operation.

As an outline for the body of this paper, we suggest the following arrangement. Inasmuch as the treatment may embrace in its scope either (1) the "structure" only, or (2) the structure and the "operation," or (3) the structure, the operation, and the "principle of operation," we assign no symbol at all to these terms indicative of the largest divisions, lest by their inclusion our entire system of symbols be disrupted. We indent them, once more, only one-fourth inch, instead of one-half inch.

BODY. (Structure and operation of the ......)
Structure. The ...... is composed, as we have said, of ...... main parts:
A. a ...... [*supply from point* a *at end of Section* A *of the Introduction*]
B. a ......, and
C. a ......
A′. The first of these, the ...... [*supply word for "main part" from* A *immediately above*] comprises in itself ...... [*supply number word*] parts:
I. the ...... [*supply an adjective modifier if one is needed*] ...... [*name the first "part,"* i.e., *subportion of "main part"; after that, if this No.* I *part does not consist of, or contain within itself, lesser members, continue with a transition, showing spacial relation, to No.* II *part. If, however, No.* I *part does comprise lesser members, proceed here as is done in* II, *immediately below*];

II. the ...... [*supply an adjective modifier if one is needed*] ...... [*name the second "part"; after that, assuming that this part includes members, proceed as follows:*], consisting of
1. the ...... [*supply an adjective modifier if one is needed; after that, if this No.* 1 *"member" does not consist of, or contain within itself, lesser "submembers," continue with a transition, showing spacial relation, to No.* 2 *member. If, however, No.* 1 *member does comprise lesser submembers, proceed here as is done in* 2, *immediately below*]

2. the ...... [*supply an adjective modifier if one is needed*] ...... [*name the second member; after that, assuming that this member includes submembers, proceed as follows:*], which is made up of

a. the ...... [*supply an adjective modifier; attend to the transition as before*].

B′. The ......, or second main part, comprises ...... [*supply a number word*] parts:

I. the ...... [*continue as in* A′].

By the simple device of running each order of symbols (A, B, C; I, II, III; 1, 2, 3, etc.) continuously throughout the outline, any particular outline symbol can be used also as a reference figure in an accompanying drawing. This insures a full set of such numerals, and avoids the working with two conflicting sets.

In case the object to be described is of a highly complex nature, the scheme used above for the main parts can to advantage be applied to the lesser topics; thus,

The .. comprises in itself three parts:

I. the .. . ( ),
II. the ... .. ( ), and
III. the . . ( ).

I′. The [*supply the word just used in* I] consists of three members:

1. the . .. ( ),
2. the . ( ), and
3. the .. ( ).

1′. The . [*supply the word just used in* 1] is made up of two submembers:

a. a . .. ( ), and
b. a . ... ( ).

Proceeding in this way, 2′ and 3′ are disposed of; then II′ and III′ with all their subtopics; and then *B′* with whatever to it belongs. A main advantage of this arrangement lies in its bringing *together* at each stage of the procedure a complete set of coordinate heads,—heads that, in the ordinary arrangement are often separated from each other by a considerable mass of details of varying classification.

By way of illustrating the movement of this type of

outline we next present a rather elaborate example describing the telescope of the Keuffel and Esser Wye Level, No. 5005. We start in the Introduction, which we find concluding as follows:

2. consisting of four main parts:
   a. a telescope tube,
   b. an objective tube,
   c. an eyepiece, and
   d. a cross-wire retaining ring, or reticule.

Body. (Structure and operation of the telescope.)
(Structure.) The telescope of the K and E wye level, No. 5005, is composed, as we have said, of four main parts:

A. a telescope tube,
B. an objective tube,
C. an eyepiece, and
D. a cross-wire retaining ring, a reticule.
A′. the first of these, the telescope tube, comprises in itself four parts:

I. a shell or barrel in the shape of a thin brass cyclinder, in a dull black "morocco" finish, 15 in. long, within which are mounted the optical elements of the instrument. Upon the upper surface of the shell, about 4¼ in. back from its front end, rides

II. a saddle plate with a turret-like termination, some ¼ in. high. About the outside surface of the shell extend

III. bearing collars made of bell metal, and tested to 0.0001 in. for parallelism, cylindrical shape, and equal diameter. From the shell extend below the

IV. supports for the spirit-level tube.

III′. The bearing collars, to which the wyes make tangential contact, are two in number:
1. a forward collar, 2¼ in. back from the front end of the tube, and
2. a rear collar, 3 in. forward from the rear end of the tube.

IV′. The supports for the spirit-level tube are two in number:
3. a post attached to the barrel in a saddle plate about ¼ in. to the rear of the forward bearing collar, and
4. a post attached to the barrel by an encircling band about ¼ in. forward of the rear collar.

B′. The objective tube has six parts:

V. the objective ("object") glass, or the forward lens of the instrument, a part permanently mounted in
VI. a cell, or brass ring, which screws tightly into the forward end of
VII. the objective head, a 1½-in. tube providing support to
VIII. attachments for the protection of the objective glass, and having fastened to its rear end

IX. two rearward-extending tubes which fit snugly without and within the shell of the telescope. To the inner of the tubes is attached

X. a rack-and-pinion device for focusing the objective glass.

V'. The objective glass, an optical device for so turning the rays of light composing the image of an object as to present that image, upside down and in its true colors, in the focal plane, that is, the plane of the crosshairs [see §D], is a 1 5/16-in. (1.30-in. effective aperture) compound achromatic lens and consists of two members:

5. a double-convex crown-glass lens, set against the back of which is

6. a concavo-plano flint-glass lens.

Note 1.—The field of view brightens even as it expands with the increase of the aperture of the object glass, because of the admittance of a greater amount of light. "Even an apparently small margin cut off makes a considerable difference in the light-collection power. For example, a 1¼-in. objective will collect .56 per cent more light than a 1-in. glass." [1]

Note 2.—The relation between the magnifying power and the width of the field of view may be assumed to be:

Power	*Angle*
20 diameters	1°30'
25 "	1°15'
30 "	1°
35 "	0°50' [2]

VII'. The objective head consists of four members:

7. a 1½-in. brass tube fitted with

8. a means of attachment for the protective appliances, and with

9. a means of attachment for the cell carrying the forward lenses, and

10. a means of attachment for its own two rearward extensions.

VIII'. The protective attachments consist of two members:

11. the sunshade, an obliquely truncated brass cylinder, with the long side at the top, which pushes back over the front end of the objective head as far as a slight bearing collar; and next,

12. the telescope cap, a brass cover with knurled forward edge, which fits over the end of the objective head as does the sunshade, and serves to protect the lens when the instrument is not in use.

IX'. The rearward extensions of the objective head consist of two tubes moving back and forth in the axis of the barrel of the

[1] I. O. Baker, *Engineers' Surveying Instruments,* p. 84. John Wiley & Sons, New York, 1892.

[2] *Ibid.,* p. 82.

telescope,—two parts that when viewed together with the objective head suggest in their cross-section an extremely narrow tuning fork, the length of whose outside and inside prongs is about in the proportion of 1 to 4.

13. The outer of these tubes, that is, the one sliding along the outside surface of the barrel as far as the bearing collar that supports the forward wye, is called from its function, the dust guard.

14. The inner, and longer, of these tubes, the one which by its close sliding contact with the inside surface of the barrel through something over half the length of the barrel insures the object glass against any unsteadiness, is known as the objective draw, and contains tightly set into its rear extremity,

Note 3.—The objective draw in some types of level is of much smaller diameter than the telescope tube, in which case it is held exactly in the axis of the latter by an adjustment ring similar to the one which in this telescope supports the eyepiece.

15. a forward-facing diaphragm of L-shaped cross-section centrally pierced with a hole of about half its diameter.

X′. The focusing device, a contrivance which brings the object glass into proper optical relation with the plane of the cross-hairs by means of giving it movement in or out over a range of some 2 in. or more, consists of four members:

16. a pinion head in the form of a milled-headed thumb-screw, riding above the saddle-plate turret before mentioned, and attached by

17. the pinion-head screw to

18. an upright spindle which passes down through the turret to a point just within the shell of the telescope, where it terminates in

19. the pinion itself, a geared wheel meshing with

20. a pinion rack rigidly attached to the objective draw, so that any motion imparted to it by the rotating of the pinion head and spindle is imparted to the objective tube in the way of extension or retraction.

C′. The eyepiece, a microscopic instrument complete in itself, whose function is to magnify first the crosshairs, and then the image cast by the object glass into the focal plane, has four parts:

XI. The eyepiece draw, a ¾-in. tube coincident in axis with the telescope tube and extending about an inch beyond its rear extremity; this draw is equipped, first, with

XII. a means of centering it accurately within the telescope tube; next, in the forward and the rear thirds of its length with

XIII. an ocular system; and finally, with

XIV. a means of movement, for purposes of focusing, forward and backward over a distance of something less than half an inch.

XI′. The eyepiece draw, upon which the other parts of the eyepiece are mounted, consists of two members:

21. a brass tube 5 in. long and ¾ in. in diameter, with rear end projecting for about an inch, as was noted, to the rear of the telescope tube, where it terminates in
22. the eyepiece cap, a protective and finishing feature, pierced in the center to permit emergence to the eye of the rays that entered the telescope by the objective glass.

XII′. The means of centering the eyepiece draw within the barrel of the telescope consists, at the forward end, of five members:

23. the eyepiece ring, a band of L-shaped cross-section, within whose inward-turning rear points slides the eyepiece draw,—a ring rendered adjustable over a small range by
24. four nickel-silver cylinder-headed eyepiece-adjustment screws which project from the outside into it through
25. saddle plates, resting upon
26. a nickel-silver band encircling the tube of the telescope. At the rear end, the centering of the eyepiece is completed by
27. the eyepiece-focusing ring, a circular cap over a forward shoulder of which the telescope tube fits snugly, and through the center of which a circle is cut away to permit the in-and-out movement of the eyepiece draw.

XIII′. The ocular system consists of three members:

28. a set of erector lenses, which reinvert into an erect position the image thrown upside down into the focal plane, and
29. a set of eyepiece lenses which magnify this image,
30. A pair of diaphragm rings of L-shaped cross-section set into the eyepiece draw between each set of lenses effect a better definition of the image by a cutting away the outside less clear and less significant rays of light.

> Note 4.—Eyepieces without the erector lenses are in a way superior to those with them, because of the possibility where they are not present of shortening the instrument and so admitting more light.

28′. The set of erector lenses is made up of four submembers:

a. a plano-convex lens with its convex side to the rear, mounted in
b. a ring that fits tightly over, and (by a shoulder) into, the forward end of the eyepiece draw; and
c. a second plano-convex lens, also with its convex side to the rear, mounted in
d. a ring that fits snugly into the eyepiece draw at a point an inch or more to the rear of the forward erector lens.

29′. The set of eyepiece lenses is made up of four submembers:

e. a plano-convex lens with its convex side to the front, mounted in
f. a ring that fits snugly into the eyepiece draw about an inch from its rear extremity; and

g. a plano-convex lens with its convex side to the front mounted at the extreme rear of the draw in

h. a ring which fits tightly over and into the rear end of the draw.

30′. The pair of diaphragms is made up of two submembers:

i. a backward-facing plate of L-shaped cross-section held to the eyepiece draw by its shorter side at a point some quarter of an inch in front of the rear erector lens, and

j. a forward-facing plate of similar construction set into the tube a like distance to the rear of the forward eyepiece lens.

XIV′. The means of forward-and-backward movement consists of four members:

31. a knurled focusing ring, encircling the barrel of the telescope at a point just forward of its rear extremity, and controlling by a slight rotary or twisting movement which may be imparted to it,—through its engaging by an oblique, or spiral, slot on its inner side—

32. a cam focusing-screw head set into the outer edge of

33. an adjustment ring, fastened to the eyepiece draw,—this movement of the eyepiece in or out extending over a range of something less than half an inch; and, finally, of

34. the eyepiece tension spring, encircling spirally, or helical fashion, the eyepiece draw between the forward and rear adjustment rings by which it is confined, and against which it works.

Note.—A rack-and-pinion adjustment of the eyepiece is open to objection because it is rather more subject to disturbance than is the adjustment by a ring with helical slot. While the objective adjustment is ordinarily made with every shot, the ocular or eyepiece adjustment is made by the same operator only once on any single piece of work.

D′. The crosswire "reticule" (i.e., "network") has four parts:

XV. crosshair ring, L-shaped in cross-section, facing with its short sides pointing forward at the top and bottom, and accurately centered within the barrel of the telescope with its rear face just at the focal plane by

XVI. four capstan-headed cross-wire-reticule adjusting screws, through whose operation—an opposite pair at a time—the ring can be shifted slightly either sidewise or up or down,—screws which come down from the outside through

35. nickel-sillver saddle plates resting on

36. a nickel-silver band encircling the telescope tube, then through

37. shutter plates, designed to prevent the intrusion of dirt or moisture through the smooth, unthreaded, holes by which the screws pass through the shell of the telescope to the points a fraction of an inch inside that shell where their points engage the crosshair ring, which carries, stretched (by weighting before gluing with shellac) tautly across its rear face upon

lines minutely scratched along its exact vertical and horizontal diameters,

XVII. the crosshairs, composed either of spider's web or of all-but-invisible platinum wire,—hairs which at their perpendicular intersection mark the precise focal point of the objective,—the exact center of the field at which the instrument is sighted; and along with these crosshairs,

XVIII. two stadia wires, similarly of either spider's web of platinum, and similarly fastened, but in lines parallel to and slightly above and below the horizontal crosshairs.

Note 5.—The platinum wires are more resistant of humidity than are spider webs, and by reason of their opacity better suited for night work. Spider webs are, on the other hand, the more readily available, especially for field replacement, the more easily applied, and the less liable to physical deterioration.

Note 6.—"Platinum can be drawn to the required fineness only by being previously surrounded by silver, which is removed by acid after the wire is drawn." [3]

The *Operation* of some instruments is simple, that of others exceedingly complex. Some instruments merely assist man as he works, others work as of themselves. In one case they but aid his hand or eye; in another, once started and empowered, they perform some single action, or action and reaction, or action continuous and interrupted, quite beyond man's unaided power of accomplishment. Naturally, this being the case, the explanations of instrumental action will differ widely from one another. For some, a single subject head will suffice; for others a number of heads are necessary, indicative of their main stages. Occasionally, as for example in the case of the slide rule, we may require not only a number of heads for the parts of an operation, but also a set of heads for the different operations to which the instrument is adapted.

The actual explanation in this case may well be looser and less stereotyped than the others we have thus far written. It can be carried forward by means of a succession of fairly loose sentences expressive of the chronological sequence of performance. Care should be taken to include every significant move, either on the part of the operator or of the machine, and to indicate all causal relationships

[3] Baker, *op. cit.*, p. 83.

existing between these actions and reactions. We begin with

the first action, wherein
some noun expressive of
material
or instrumental part, is
represented as being subjected to the action of

some verb, which latter will usually be accompanied by
some modifier, specifying as to

the place or direction,
the time or frequency,
the means or method,
the purpose or what not,
of the action, after which some
proper transition leads us to

the second, or to
a second and third action that together

either themselves advance
the operation to the place where
the result desired can be obtained,
or set in motion the machinery, of which

a first part acts in a certain way upon a second, and
this second part precipitates some action in a third,
until at length
its proper end is accomplished either

in its own production of something
or in its contribution to the combined activity of other
machinery with which it is linked up.

Thus in explaining instrumental action we may go from preliminary inspection or observations to the placement or adjustment of the parts, and from these to movements such as are involved in the application of power; and once power has been applied, we have but to follow, with whatever keenness of perception we can command, the concatenation of mechanical causes and effects by which a cycle of performance, one "turning over" of the machine, is brought to pass. To follow such a train of performance without a slip is a piece of work of which any one may well be proud. The intellectual discipline involved in it will compare favorably, we here submit, with any training connected, let us say, with the production of a familiar essay.

The Completing of the Presentation

Let no one think that the form of the analytical outline is necessarily that of the final writing. Far from being an end in itself, this outline is merely a means to an end,—that end being the completion of one stage in the whole composition, the working out of facts into sequences that are first coordinate and then related. In our pursuance of this end, we make several departures from normality. Long sentences we use, because in them the direction of thought is less liable to change than it is in a sequence of short sentences;—and we want at any cost to hold our point of view. Identical forms of transition we use also, in all places where the order and character of the adjacent members remain the same;—for in no case must our train of thought be switched off the track.

Characteristics of the Finished Article

When, however, we come to the writing up of the material in its finished form, we subject all these working devices to considerable change. While the sequences of nicely articulated members—nests within nests of them—remain in their carefully worked out position; the temporary matrices of the long sentences are broken down into whatever lengths promise to be most easily comprehensible. The stiff and stereotyped phrasing gives place to diction that is well modulated and carefully graduated throughout; the segregated notes work into the body of the whole; and the monotonously reiterated connections are so varied as to become inconspicuous and almost to disappear. So the result of all our efforts is not a progress through courses that seem no less endless than difficult, but rather an advance, down smoothly continuous currents, always clear and always refreshing,—streams that bear the mind by easiest stages into that port it had a mind to reach. But in no sense is it true that this flexibility means any departure from logical principles. All major heads should be organized, should be truly "structural."

Exercise.—The following lists suggest topics susceptible of treatment in the ways indicated in this chapter.

agitator, airpump, alidade, alternator, ammeter, anemometer, anvil, -apparatus, -arc, -attachment, audion, balance, barometer, battery, binoculars, boiler, brake, bridge, cable car, caliper, calorimeter, camera, carburetor, cathetometer, chartometer, chronograph, classifier, clinometer, clutch, coil, compass, compressor, condenser, converter, coulometer, counter, cupola, derrick, detector, drill, dynamo, dynamometer, economizer, electrodynamometer, electroscope, electrometer, electromagnet, ellipsograph, -engine, evaporator, excavators, filter, furnace, gage, galvanometer, generator, governor, gun, humidifier, hydrometer, indicator, inductometer, -instrument, jack, kiln, lamp, lantern, lathe, level, lubricator, -machine, magneto, manometer, megger, -meter, micrometer, mill, mixer, motor, nozzle, oscillograph, -oven, pantogprah, permeameter, phonograph, photometer, piezometer, pistol, planimeter, plane, planer, polarimeter, polariscope, potentiometer, press, planer, protractor, pump, pyrometer, radiometer, ram, rattler, receiver, rectifier, refractometer, relay, rheostat, rifle, -rod, ruler, scleroscope, scraper, separator, sextant, shaper, spectroscope, spectrometer, speedometer, synchroscope, tachometer, telephone, thermocouple, thermometer, thermometry, thermostat, thickener, torch, transformer, transit, transmitter, tube, turbine, turret, -valve, variocoupler, viscosimeter, vise, voltmeter, wattmeter, wavemeter. welder, wrench.

blast furnace, blow torch, dry cell, electric bell, electric horn, field glasses, force pump, gin pole, head phone, lamp bank, loud speaker, pile driver, plane table, pneumatic hammer, pug, mill, road drag, sketching board, -slide rule, spark plug, specific-gravity flask, starting box, telegraph sounder, vacuum tube.

Such terms as the foregoing are modified in various ways for the purpose of distinguishing particular designs; for example, by reference to

The Inventor. Abney —, Bell —, Bessemer —, Bourdon —, Corliss —, d'Arsonval —, Diesel —, Dorr —, Emmet —, Hvid —, Jolly —, Locke —, Mannheim —, Parr —, Picout —, Stillson —, Venturi —, Vicat —, Weston —, Wheatstone —.

Purpose. annealing —, blue-printing —, compensating —, drawing —, milling —, recording —, separating —, throttling —, welding —, wood-turning —.

Principle. automatic —, ballistic —, capillary —, centrifugal —, differential —, impulse —, hydraulic—, hydrostatic —, induction —, magnetic —, projection —, precision —, prismatic —, resistance —, tangent —, synchronous —.

Means of Operation. all-fuel —, compressed-air —, electric —, gasoline —, oxy-acetylene —, steam —, spirit —.

Structural Feature. *compass* galvanometer, *cylinder* pump, *hook* gage, *jet* condenser, *pendulum* governor, *ratchet* drill, *shunt* dynamo,

siphon barometer, *turret* lathe, *vacuum* tube, *vernier* caliper, *wheel* scraper; *carbon-disk* rheostat, *combustion-bomb* calorimeter, *continuous-current* generator, *gravity-balanced* spindle governor, *four cycle* gas engine, *inclosed* beam balance, *mercury-arc* rectifier, *movable-core* ammeter, *moving-needle* galvanometer, *oscillating-arm* shaper, *suspended-coil* galvanometer, *thermo-couple* ammeter, *vacuum-tube* rectifier, *water-cooled surface* condenser.

Material worked on. *air* compressor, *alemite* gun, *brick* rattler, *current* meter, *metal* lathe, *rain* gage, *revolution* counter, *steam* indicator, *steam* separator, *water* meter, *watthour* meter.

User. *carpenter's* level, *electric-lineman's* cable car.

Product. *spark plug, vacuum* pump.

Shape. *crescent* wrench, *dumpy* level.

Operation. *rolling* planimeter, *repeated-impact* testing machine.

Miscellaneous. aneroid barometer, electron tube, engine indicator, monkey wrench, parallel rule, polar planimeter, prony brake, safety valve, solar attachment, storage battery, telegraph instrument, telephone transmitter, acoustic current meter, electrostatic induction machine, polyphase duplex slide rule, polyphase induction motor, single-phase Bell transformer, slow sand filter, squirrel-cage induction motor, throttling steam calorimeter, two-cylinder pneumatic airpump, universal drafting machine, vibrator-condenser induction coil.

CHAPTER VI

CAPITALS AND ITALICS

CAPITALS

Capitals are used to mark beginning words and distinctive designations, to distinguish certain deviations from other lower-case forms, and to give to a term a certain amount of emphasis.

In their first use we find them placed on the opening words of sentences; lines of verse; quotations which do not begin in the midst of a sentence; headings of paragraphs, sections and articles; major items in non-continuous outlines or tabulations; matter following a colon, when this matter is logically equivalent to a sentence, or when it constitutes the first item of a series (each item of an important list may receive an initial capital); and in resolutions, on the words immediately following the terms, WHEREAS, *Moved*, and *Resolved*.[1]

To set off distinctive designations, capitals are used, first, with personal names, and then with impersonal names. In the former sense they serve as initials on the names of people, and the titles borne by people; also, on the names of peoples in the mass, and of organizations. In the latter sense they serve similarly to designate specific locations and distinctive objects; units of time and events of importance; literary productions and their parts, and also products or articles of manufacture.

Personal names (surnames or Christian names, nicknames or pseudonyms) together with the initials and other abbreviated forms of such names, are capitalized when used either as nouns or adjectives; also, common nouns used—as

[1] In manuscript, small capitals are indicated by double underscoring; full capitals, by triple underscoring; and italics, by single underscoring.

in references to the parties to a contract, or to the important members of an organization—to indicate specifically some individual or individuals. Names of trades or occupations are not capitalized. Proper adjectives attached to terms of science or industry tend to drop the capital as the connection of the thing named with its originator or place of origin ceases to be significant. When this time comes in any case is difficult to determine; but we can say in general, that the sooner it comes the better.

Titles, official or honorary or professional, take initial capitalization, either when they accompany a name, or when they are used by themselves with specific reference to the bearers. Note that the prefix *Vice-* is capitalized, but not *ex-*. Academic and professional degrees likewise take capitals; as also do the nouns occurring in the salutation or in the complimentary close of letters.

The designations of races, nations, states, legislative bodies, political parties, popular movements, denominations, associations, federations, commissions, institutions, faculties, academic departments and subjects, corporations, firms, and the like, take initial capitals on all important words; that is, in general, upon all words except articles, prepositions, and conjunctions. Distinctive parts of such names are likewise capitalized when they are used with specific reference to the thing designated by the name. The definite article preceding such designations is not capitalized.

The names of planets and other celestial phenomena (except the sun, moon, and, sometimes, the earth), geological and geographical and political divisions of the earth, cities, distinctive locations, natural or artificial objects of note, architectural structures and engineering projects, the cardinal points when used with reference to some particular part of the country or to its population, are all capitalized. The passing of a border line exceedingly difficult of determination is seen in such terms as, the Mississippi *basin,* the Appalachian *watershed,* the Atlantic *seaboard,* and the Pacific *coast region.* In most writing, outside the newspapers, capitals are given such common nouns as *street, avenue, sea, sound, gulf, monument, bridge,* or *building,* when these occur as part of a name.

The names of geological or historical or cultural periods,—such as epochs or ages; the names of events or gatherings; the names of years in the form "in Seventy-five"; the names of the months and of the days of the week are capitalized, but not those of the seasons or of the centuries.

The names and titles of published works,—book names; periodical names; the names of laws and enactments; of public or legal or commercial documents; the names of rules and formulas and theories; the specific titles of parts of publications, and of their mechanical divisions, down to *page* and *paragraph,* are capitalized on the first word and on all other words save articles, prepositions, conjunctions and, sometimes, pronouns and minor verbs. An initial article is capitalized in the case of book names, but the definite article before the name of periodicals is not capitalized. In the case of long titles, capitals may be omitted, especially in footnotes or references, from all words but the first.

Trade names, commercial brands, grade designations, distinctive makes of machinery, and the like are properly capitalized.

Capitals are used arbitrarily in certain abbreviations that otherwise would be confused with lower-case forms, in symbols in tabulation and in reference work; and sometimes, also, to call attention to a new topic of discourse upon its first appearance.

With most of these usages the student should already be familiar, and, with others also not mentioned here. The purpose of this chapter is merely to provide a check list, and to bring this elementary subject before the attention for a rapid review. The one most useful rule that the writer has ever heard regarding capitals is to avoid them in all cases of doubt.

Exercise.—Give reasons for or against the following uses of capitals.

1. macadam, the League of Nations, for Grades I and II, the French coefficient, the Engineer shall instruct the Contractor to proceed, the Chicago Drainage District
2. roman numerals and arabic figures, both Congress and the executive departments, in the absence of the Chief Engineer, the North Atlantic States; *Whereas,* We the

3. prussian blue, the Government's policy, the Near East, Halley's Comet, the Fifty-third Congress
4. the British thermal unit, the Dean went on to, the Chicago *Tribune,* the Battle of the Marne, Cleopatra's Needle; is as follows: Electrodes, $150; current, $54; labor, $50
5. five pullmans, where the Code is silent, the President's secretary, My dear Colleague, The Solid South
6. the Bessemer (or bessemer) process, going south or south-east we strike the so-called southern States
7. portland cement, the Bureau of Standards, the published report of the Commission, Section 2
8. The Canal Zone, Michigan Avenue, the *Evening Times,* the Standard Classification of Timber Defects
9. india rubber, the attitude of the Legislature toward the University, the Brooklyn Suspension Bridge
10. the Continent, the author's statement that "Steel pipe is . . .," Vol. II, page 10, the Flatiron Building, Labor Day, in the Appendix

ITALICS

Italics are distinguished from "roman" letters by a single straight continuous underscoring.[2]

Among the prominent uses of italics we note the following:

Titles of literary productions of book size; also, of works of art. Note here that an introductory definite or indefinite article should be included by the italicization.

Names of newspapers, magazines, journals, bulletins, proceedings, etc. Note that italics are not extended to include the place of publication or the society issuing the publication; and that in the case of newspapers an introductory definite article is not italicized. Note again that a periodical usua'ly prints its own name in small capitals.

[2] Note.—The double underscoring of a word indicates a desire to have it set in SMALL CAPITALS (for small capitals with higher initials, double underscore all but the initials and triple underscore the initials, thus: CAPITALS AND SMALL CAPITALS); and triple underscoring, a desire to have it set in full capitals (capitals high throughout). Similarly **bold-face** type is indicated by underscoring with a wavy line which may be supplemented as before by straight lines for capitals, LARGE or SMALL.

Marginal headings, paragraph titles, or words otherwise introducing paragraphs, or the divisions of resolutions.
Official designations accompanying names of persons either listed, or in signatures.
Names of vessels, airships, trains, etc.
Important expressions calling for vocal emphasis, or words to which for any reason the writer desires to attract attention.
Detached terms or letters (used either as nouns or as symbols, or in the form, the "*of*—construction") occurring in textual matter.
Unnaturalized foreign expressions.
Certain less familiar Latin adverbs, abbreviations of reference, notably, *circa, ibid., idem, infra, passim, supra, vide* (also *see*), *viz., ad loc., loc. cit., op. cit., q. v., et seq.;* but not, cf., e.g., i.e., etc., vs., or viz.
Latin names of genera in scientific classification.

CHAPTER VII

THE PRINCIPLE-OF-OPERATION PAPER

Theory.

- Its relation to structure and operation.
- Its distinctive vocabulary.

Procedure in the theory paper.

- In the body.
  - Statement of law.
    - Its interpretation.
    - Its illustration.
  - Presentation of apparatus.
    - Its structure.
    - Its operation.
- In the other divisions.
  - Introduction.
    - Definition.
    - Division.
  - Conclusion.
    - Comparison.
    - Particularization.
- The composite outline.
  - Its wide applicability.
  - Its extreme practicality.

Structure is structure; it is not operation; it is not theory. Yet to any full realization of structure some acquaintance with operation and theory may well be essential. The way a tool is handled often throws light on the reason for its shape. The graduations of slide rule or level rod first take on meaning with our use of the instruments. With power-

operated and automatic machinery, this fact is increasingly evident. One "turning over" of the machine can throw a great deal of light upon the reasons underlying its design. It may not, however, satisfy the mind as to the principle by which it operates. Something yet unexplained makes effective the slide rule, the sextant, the speedometer, the calorimeter, the centrifugal pump, the hydraulic ram. With the explaining of this something, we shall in this chapter concern ourselves.

In a full presentation of a piece of apparatus we may be expected first to touch upon its origin, then to sketch the story of its development, and finally to tell something of the various modifications by which it is adapted to different kinds of service. But all this, one should realize, is general discourse, not technical. The latter sees only structure and operation and the principle of such operation. All three of these concern themselves with the important matter of performance, on the one side of which lies pure science with its natural laws, and on the other side applied science with its skill in practical contrivance. We may approach performance from either side—from that of sense perception, or from that of intellectual perception. The former approach is occupied with appearances and outward forms; the latter, with theories that assume to account for the moving of the wheels. Already in this book we have sketched a line of treatment for the structure-operation paper; now, though much more briefly than before, we shall suggest one for the operation-theory paper.

At the start we would call attention to a group of words inevitably involved with the sort of discussion upon which we are entering;—words which should accordingly be considered studiously, both in their derivation and in their application throughout the range of scientific and related literatures. They are *law, principle, theory, hypothesis, formula, theorem, fact,* and *truth;* and to them we may do well to add, *rule, statute, doctrine, postulate,* and *corollary.* The differentiation and possible interchangeability of terms in the list should be carefully noted. Though we speak of the "law" of causality and the "law" of gravitation, we shift over to the "principle" of least action, to the "principle" of

virtual velocities; and while we speak of Newton's "law" of motion, we refer to D'Alembert's "principle" in mechanics. In short, the "principle of operation" does not carry just the same force as does the "law of operation." At a certain stage of knowledge we have "hypotheses" and "theories"; but theories of lenses may become principles of optics, and hypotheses regarding trajectory may, after due checking of experiments, become established as basic laws of motion. Ultimately such conceptions are likely to be reduced to the briefest algebraic expression in which case we have *theorems* and *formulas* and *equations,* in which shape they become the more readily applicable to concrete situations. These last often bear the names of those who devised them. Practically, but not in absolute fact, they may be taken as the starting points of explanations of mechanical theory.

Procedure in the Theory Paper

To make clear the principle of a machine, we should first state it in some comprehensive form. Such a law of motion we might express by saying that we know that a moving force tends to travel in a straight line unless it is acted upon by some outside force; and then, that its deflection is proportional to the intensity of the force resisting it. This initial statement may be rendered more explicit by a defining of the possible natures of the moving and resisting forces, and by a detailing of the character and extent of the resultant deflection. The way is thus prepared for a formal restatement of the basic principle in terms that are likely to be more intelligible than were those of the theorem or even of the principle.

At this point, an example, more particularly one from familiar ground, may well be brought in to further the explanation. Thus a homely illustration of our law of motion might be the straightening out of a coiled garden hose with the turning on of the water. The magnet, the thermometer, the teakettle, and the icecream freezer afford other examples of natural laws operating in commonplace situations.

Half of our work of explanation is completed with this example. The other half brings us back to the mechanical features of the subject itself. Now our device, whatever it may be, we here regard less as a fabric of visible parts in space than as a means of bringing about certain actions and reactions whose sum is a desired result. Our concern in this case is not with the containing tubes of a telescope but with the number and shape and sequence of its unseen cones of light. Naturally, this part of our explanation involves a tracing out of sequences of causation, and a throwing of light on the why and wherefore of whatever confronts us at each several stage. Progress here should be slow and systematic and complete in its coverage.

The introduction, here as elsewhere, is devoted to the business of definition and division,—to a presenting of the nature of the subject and of the lines to be pursued in the course of its discussion. The conclusion, again as always, should be governed by circumstances. Possibly it may make mention of other instruments that show an adaptation of the principle just considered; again it may point out deviations from the form just presented in other types of the same instrument. Once more, it may touch upon the present perfection or possible limitation of the device, or hold in comparison the advantages or disadvantages of these several types, and their adaptability or inadaptability to various kinds of work. But, whatever it does, the conclusion should be pertinent and informative, both in form and phrasing—altogether perspicuous, and altogether incisive.

The following outline presents, more loosely than in those given before, a scheme for the handling of such a topic as is here suggested.

THEORY OF THE . . .

INTRODUCTION. (Definition and division.)

A. The . . . . . . is an [*supply* instrument, *etc.*]

I. finding a use

1. among

a. . . . . .s [*supply word for users*] and

b. . . s [,, ,,],

2. in the operation(s) of
   a. ......ing ...... [*supply a verbal noun and its object*] and
   b. ......ing ...... [,, ,,; *note here that if, as is not likely to be the case, the machine or instrument is used by only one class of workmen, and for only one sole purpose, the items at* a *do not appear as separate topics, but join with the main topics* 1 *or* 2 *above. We use no single symbol*]; and

II. exhibiting structural features
   1. which appear, as regards general shape and dimensions, in the accompanying sketch:

Box to indicate the position of the sketch, which itself will appear on a separate sheet.

   2. which adapt it to the utilization of a principle of mechanics implicit in a law of .... . [*supply a term expressive of the field of the basic, underlying law*].

B. The purpose of this article is to set forth
   I. this principle, and also
   II. the particular mechanical design through which it is caused to operate.

Body. (Principle and operation of the ......)

A. (The general law.) The ...... [*supply a term expressive of the known cause underlying the action of the machine or instrument, such as,* law, principle, *or* theorem] of ... [*supply a term expressive of the field, such as* optics *or* hydraulics] states that ...... [*fill out the statement; note that this statement may be positive or negative, actual or hypothetical, single or variously duplex; in every case, however, expression must follow the facts and borrow its order from the logic inherent in any scheme of things that work*].

I. (Expansion.)
   1. We know, in other words, that ...... [*fill out the restatement of the principle stated more formally just above.*]
   2. To state the thing still more explicitly, we know that ..... [*fill out; note that in most exceptional cases no. 2 can be found (about as often as "unplayable balls" occur in golf), in which case* 1 *loses itself in* I].

II. (Exemplification.)

1. We know, for example, that in general ...... [*supply a proper connective, such as,* if, whenever, wherever] a ...... be ......ed ...... [*supply where necessary a modifier of the participle*]......[*supply* it, the ......, *or other suitable term*] will ...... *state the known result following upon the particular action.*
2. To take a concrete illustration, we know that when .... [*state what is done and what follows*].

B. (Adaptation of the ...... to the operation of this ......) Now in the ...... this knowledge of the behavior of .. is applied in the following manner:

I. (Working parts of the ......) The structure of the ...... [*supply appropriate term, such as,* machine *or* instrument] shows

1. a ..... [*supply first main part*], consisting of
   - a. a .... [*supply subordinate parts*] and
   - b. a ..., which is ......ed to
   - c. a ...... [*Proceeding thus, complete the description, stressing throughout the WORKING parts and their OPERATIVE relation to one another.*]

II. Operation of the ....) Now in consequence of these features of construction, it follows that when .... [*Trace through each step of the action of the device, at each point showing the reason for what takes place. Sometimes, of course, an antecedent action may be double or multiple, and the result ensuing, single; and again, the antecedent action, though single, may bring about an effect that is other than single. Finally, the result of the first stage, as represented, may prove but a transition to stages following after it.*]

CONCLUSION.( ) [*fill out as in the case of preceding papers.*]

In these three expository outlines we have advanced from ideas fixed in the time sequence, through those considered in intellectually determined relations of space, to those associated with each other in the most subtle and intangible relations of causation. Under all these conditions alike we have made use, with but slight modifications, of a single general form of outline arrangement. And wide as has been the range of our exercises, the applicability of this literary

apparatus has never been seriously strained. We trust that this general scheme has approved itself not only as a device making of logicalness and completeness in a general and theoretical way, but as one specifically and practically valuable in its meeting of the multiform requirements of communication in the world of affairs.

CHAPTER VIII

ABBREVIATION

Language, like everything else, is much given to shortened forms. Most of us can talk, as it is, faster than we can think, still the process of shortening goes on. The results of this shortening become more evident when we begin to write. They appear in contractions colloquial and otherwise (usually taking the apostrophe but no period, *it's, I'll, gen'l, rec'd*), in the shortening of long words to some one outstanding syllable, in the use of signs and symbols for words, and in simplified spelling. The most regular shortening, however, occurs in the case of the several thousand abbreviations that occur in every sort of writing outside that which is strictly literary. The frequency with which these are found in engineering writing calls for some discussion of them here.

Abbreviations make for the economical presentation of ideas. They give us a meaning at a glance, where the interpretation of the full verbal symbol would necessitate a more lengthy, even if largely unconscious, mental process. Moreover, besides conserving the reader's attention, they save the writer many a pen stroke, and so facilitate the setting down of his ideas. Again, wherever limitations of space put a premium on compactness of presentation, abbreviations prove convenient and even indispensable.

These facts, however, are not sufficient to warrant their use indiscriminately. Although with the advance of writing toward the severely technical, their presence becomes more and more justifiable, even here definite limits have been found necessary. In first-class publications the restrictions are most evident. This avoidance of too general abbreviation arises from the fact that they are more liable to misunderstanding and alteration than are the full forms for

which they stand. Accordingly, where accuracy and certainty become especially important, as for instance in specifications, abbreviations should be used sparingly if at all. A second reason for such restriction is found in the lack of uniformity in the making of abbreviations, and in the ambiguity ensuing from the duplication of meanings for signs and of signs for meanings. Thus *gram* and *grain,* and *effective horsepower* and *electric horsepower,* and *brake horsepower* and *boiler horsepower,* invite and too often get the same contraction. In fact, almost every letter in the alphabet is made to stand for different and distinct ideas. So it comes about that a device used rather freely in every-day writing is more and more avoided in formal correspondence, where a mistake, an alteration, or an ambiguity might involve the writer in unpleasant consequences. In short, these contractions are a convenience rather than a necessity; and, accordingly, the writer should play safe when using them. This safety lies in abbreviating only such terms as the reader cannot fail to understand.

Non-abbreviated forms

In ordinary prose all casual expressions should be spelled out, even though recognized abbreviations for them are to be found. *Addresses* should not be abbreviated as in the headings of letters. *Titles of distinction* such as "the Reverend," "the Honorable," "Professor," "General," and "Governor" are correctly abbreviated only when they are followed by Christian names or initials. *Christian, or given, names* are abbreviated only to initials. *Names of the months and days of the week* are not abbreviated at all in text. *Names of cities and towns* are not abbreviated. *Names of states and countries* are abbreviated only when preceded by the name of some city or town. *Names of industrial concerns* are abbreviated only in the manner authorized by the practice of the companies. *Parts of a book* are abbreviated only in citations followed by a figure of identification. *General terms* such as "building," "forenoon," "mountain," and "materials" are not abbreviated. *Partly abbreviated phrases* such as "per yd.," "length in ft.," "the third vol.," and "the sp. gr. is low," are uniformly

condemned. *Units of measure* are properly abbreviated only after a figure indicative of the number of such units taken. *Short words of measure* which abbreviation could reduce by only one or two letters are better written in full (e.g., *bag, bale, box, cask, mile, peck, ton, watt, volt*).

The Spelling of abbreviations

The form of contraction is unpredicable, and in nowise amenable to dogmatic rule; a fact that is sufficiently evident when we consider the shortenings of the following *"omni-*bus," "mob-*ile vulgus,"* "auto-*mobile," "aero*-plane," *"tele-*phone," "tel-*egraph," "in*-flu-*enza,"* "cab-*riolet"* (diminutive of Fr. *cabriole,* "a little leap," from Lat. *caper,* "a goat"), or "taxi-*cab."* Naturally, to legislate regarding such unaccountable formations is particularly difficult, yet in the case of technical contractions standardization of some sort is desirable. The same need of uniformity is not felt in the case of terms of more general applicability. Thus the *Industrial Arts Index* puts abbreviations of magazine names into bold-face type, omits the periods, and trims down the words most severely; yet in its limited field of bibliography, especially with a key at hand, the reader is able quickly to translate *Am Soc M E J* into "the *Journal* of the American Society of Mechanical Engineers," and *Mo U Sch Mines & Met Bul* into "the *Bulletin* of the School of Mines and Metallurgy of the University of Missouri." So too, *J* is sufficient indication of "Journal," and *O* of "October," although elsewhere *Oct.* and *Jour.* would be much preferred. The test of sufficiency in any case is immediate recognition under the circumstances where the word is used. Whereas *m.g.d.* (million gallons per day) would in its proper context be intelligible to almost any civil engineer, such forms as *g.a.d.* or *m.g.a.d., g.p*(.)*c.p*[.]*d.,* or *m.s.c.p.,* for "gallons per acre per day," and "million gallons per acre per day," and "gallons per capita per day," or "mean spherical candle power," would be pretty sure to cause perplexity; and in the better-edited journals the familiar "cubic feet per second" is far less likely to be shortened to *c.f.s.* than to be given the longer and more obvious form *cu. ft. per sec.* (or even *second*).

Consistency within the limits of a single article is reasonable and desirable. That one has the choice of *Jour.*, *Jl.*, and *J.*, or of *versus*, *vs.*, and *v.*, is not sufficient justification for mixing them all up in the same article.

Forms of abbreviation

Something of the variety of ways in which abbreviations are made appears in the following list: A, C, I; F., M., R., R.R., W.W., a., c., i.; co., cu., ed.; abs., cap., max.; mfd., mfg., mfr.; cent., segm., hyst.; avoir., contr., corol.; hypoth., constr., specif.; pd., bk., mdse., hdq.; cm., mm., cl., ml.; emf., mmf., kva.; bbl., hhd.; cwt., dwt., kip.; lb., ct.; cp., hp.; ag., pb., fe.; Do., No.; cos, tan, sec; sinh., cosh., tanh.; a.c., b.m., l.t.; at. wt., sp. gr.; deg. cent., hyd. gr.; ° C., ° F.; ff., pp., ll.; 4 to, 8 vo., 12 mo.; MS, MSS; LL.D., Ph.D.; B.t.u., B.w.g.; amp-hr., kw-hr.; m.c.p., r.p.m., n.t.p.; l.p(er)w. (lumens per watt), p.p(er)m. (parts per million); O.D., F.S.; F.W.L., c o.d., f.o.b., c.w.o.; F.&D., T.&G.; B.&S.G.; c.ofg., c. to c.; a.m., p.m.; cf., sc., vs.; oz., viz.; i.e., e.g., *q.v.;* w/b, b/e, c/o; *op. cit.*, *loc. cit.; et al.*, *ad inf.*, *in trans.*, Q.E.D.; *inst.*, *prox.*, *ult.;* etc., *u.s.w.;* R.S.V.P. (*not* "real silver wedding presents").

Units following numerals

In textual matter abbreviations have perhaps their chief use in representing standard units of measure following numerals. Where alternative forms exist, preference should go to the simplest which the context will warrant.

Singular for plural

In the case of units of measure, the singular form serves for both numbers. save in the case of the common units of time. General objects, on the other hand, usually have both singular and plural forms.

Compounds

In the case of solid compounds, the solid form of abbreviation seems most reasonable, for example, *hp.* for "horsepower" and *cp.* for "candlepower"; *emf.* for "electromotive

force" and *mmf.* for "magnetomotive force"; cm. for "centimeter," and mm. for "millimeter." [Cf. *b. hp.* (brake horsepower), boiler horsepower (unabbreviated), *hp-hr.* (horsepower hour); *a. hp. e. hp., f. hp., w. hp.* (for "air," "electric," "friction," and "water horsepower," respectively); also, *cm.* for "cubic centimeter," along with *c.c.*).] This reserves *h. p.* for "high pressure," and *c. p.* for "chemically pure." In time, almost inevitably, we shall have *rpm.* and *ppm.* for "revolutions per minute," and "parts per million."

Punctuation and abbreviations

As a rule, abbreviations are followed by periods, just as colloquial contractions are indicated by apostrophes. The following exceptions, however, should be noted: Chemical elements, or "symbols," (*A* for "argon," etc.); trigonometric functions (*sin, tan,* etc.); *per cent* (for per cent.); MS and MSS; the format of books (*4 to, 8 vo, 12 mo*); the ordinal signs (1^{st}, 2^{nd}, 3^{rd}, etc.); the ampersand (&); a letter used as a name (*J* Brown).

Separate compound nouns when abbreviated usually take a period after each of the component parts. In such cases no space is left between intermediate periods and the following letters; thus *B.hp.*, not *b. hp.* Solid compounds take a period after the joined letters, thus, *cwt.* for hundredweight.

Hyphenated units of measure, when abbreviated, retain the hyphen and take a period at the end, but none after the first element; thus, *sec-ft., kw-hr., ft-lb-sec.* In the case of hyphenated expressions other than units, usage is less uniform, yet such forms as *a-c. generators* have behind them the best authority. In compound adjectives, the hyphen is retained in such cases as, *a 4-in. sample* and *75-mm. ammunition.*

Phrases, when abbreviated, take periods only after words that are reduced; thus, *mm. per hr. per sec.*

The plurals of abbreviations, like those of signs and letters, take the apostrophe and *s;* thus, "the sum of the *emf's* A and B"; but usually such forms would be written out in full.

Capitalization of abbreviations

As a rule a capital should indicate an original proper noun or adjective; but, in part, the use of capitals is arbitrary and conventional. Wherever a choice is offered between capitals and lower-case letters reason argues for the simpler, non-capitalized form; thus, *B.t.u.*, instead of *B.T.U.* or *B.Th.U.* Sometimes, however, the arbitrary use of a capital in abbreviation serves to distinguish the contraction of one word from that of another; as, for instance, in *dist.* (distance) and *Dist.* (District); *imp.* (improved) and *Imp.* (Imperial); *m.* (meter) and *M.* (moment of forces, one thousand, etc.); *r.* (radial) and *R.* (resistance).

At the beginning of notations and the like, capitals are called for in the case of abbreviations as of other words. Titles and scholastic degrees are capitalized; so also is the abbreviation *No.* for the word *number.* Isolated citations to parts of a book when used in the text are regularly capitalized, but frequently not when they occur in sequence in complete references.

Illogical capitalization is seemingly fixed in the case of numerous engineering terms, many of them connected with shop and field work, where for large and rapid notations and for quick casual reference the larger forms of the capitals recommend themselves. Here we might mention among two or three dozen such abbreviations, *B.M.* (bench mark); *H.I.* (Height of instrument); *O.D.* (outside diameter); *P.D.* (pressure difference); *I.H.P.* (indicated horsepower); *K.D.* (Knocked down); *F. & D.* (faced and drilled); *T. & G.* (tongued and grooved); *F.A.O.* (finish all over); and *P.I.*, *P.T.*, and *P.C.*, for the "points" respectively of "intersection," "tangency," and "curvature."

Italicizing of abbreviations

Italics are used for abbreviated names of publications (the *Proc.* of A.S.T.M., 1920); and also for the less common Latin abbreviations, that is, for most of them except, perhaps, e.g., i.e., etc., and viz.

With this we must close these comments, observing only, in conclusion, that at the very beginning and end of

sentences abbreviations should be avoided. Usage, here, however, as in many other respects, is far from fixed. The safeguard of the writer lies in observing constantly the practice in the best-edited texts. The use of signs, we note, although akin to that of abbreviation, lies outside the proper scope of such a book as this.

CHAPTER IX

LETTER WRITING

The importance of letters.
    Epistolary conventions.
    Epistolary forms.
The mechanical form of letters.
    The materials.
    The makeup.
    The folding, etc.
Two representative types of letter.
    The letter of request.
    The letter of application.

Literature is the world of letters; and letters include a world of literary forms. The postal service has become one of the outstanding means of bringing together the ends of the earth. Scarcely any concern nowadays but extends its ramifications beyond its own locality. Its representatives in these outlying regions, its clients and customers, are kept in touch through the medium of constant communication by letters or by wire. This has led to the development of a considerable number of well-recognized types, that, as the result of constant use, are rapidly tending toward standardization, especially regarding the matter of outward form. But as the standardization of stanza forms in prosody, say of the sonnet, has by no means driven all poets to write alike, so in this case the observing of well-recognized conventions of correspondence will never prevent anyóne, possessed of personality and of something to communicate, from expressing himself with all apparent force and freedom. Indeed this ability to move at ease within restrictions is the first criterion of the highest artistry. The logic of the composite form at last evolved, is that approved of many an

attempt, and so the perfect logic of oft-proved practice, to which reason will instinctively conform.

We have, we said, many sorts of letters. First, formal social correspondence,—letters of invitation and acceptance, of congratulation and of condolence; and of less formal kinds, the endless epistles of a friendly nature, ideally made up, if we may believe Charles Lamb, of news, sentiment, and puns. Then comes the correspondence of business,—letters of inquiry and request, of introduction and recommendation, of application and resignation; sales letters, both primary and follow-up, order letters, complaint and adjustment letters, credit and collection letters; letters handwritten, and letters typed and printed, letters mimeographed and multigraphed and hectographed; single and occasional communications, and form letters individual or in series broadcast or circularized as part of some publicity movement or campaign. Besides these, we have professional and official reports which amount to letters, sometimes definite and sometimes periodic, which detail the results of special investigations, or the progress or completion of important pieces of work.

The engineer who would maintain the true professional attitude should make it his business to familiarize himself with the approved usages in all these several sorts. Space in this book, however, can be given to only two sorts of special letter, those which the young engineer will have occasion first to write,—that requesting a testimonial, and that making application for a position.

The Conventions of Letter Writing

The Makeup of the Letter

Many a young engineer who has found his first professional employment to consist almost exclusively of correspondence work, has discovered to his confusion and dismay the intricacy of the technique governing epistolary form. Conventions, he has discovered, of display and of disposition whose nonobservance could detract materially from the effect of any message he might produce. Both for his own

guidance and for that of any subordinates, the engineer should know at least how things ought to be done—how they are done in the practice of concerns of reputable standing. To present certain usages that are rather widely accepted is the purpose of this section.

A letter should be written on a good quality of white bond or linen paper, in sheets 8½ by 11 in., and without ruling (if the letter is handwritten, a lined slip-under sheet may well be used). Envelopes, approximately 6½ by 3⅝ in., should in quality match the paper. The color of ink most to be recommended is black or blue black.

I. The Letterhead

Content.—The name of the individual or the concern; some indication of the character of the business; possibly a notation regarding the identity of the department issuing the stationery; together with the mail address, either printed, engraved, or lithographed, form the letterhead. With these, the more essential and usual items, are often combined a list of names of general officers, of the location of branch establishments, the cable address and telephone number, and the seal, trademark, motto, or slogan of the organization.

Purpose.—The letterhead, used on the first page only of a communication, presents in a most compact form general and specific items of information that would inconvenience the correspondent to look up, suggests the character of the business, obviates the necessity of a repeated writing of the house address, and often helps in the identification and proper placement of the person sending out the letter.

Position.—Ordinarily the letterhead may be expected to occupy the space from ½ in. down to 2½ in. down from the top of the sheet, the principal name being centered on the page.

II. The Heading

Content.—(1 a) Street number, (b) street,
(2 c) Town or city, (d) state,
(3 e) Month and day, (f) year.

Where a letterhead is used, only such information as is required to supplement it, appears in the heading.

Purpose.—To afford the recipient at a glance all the data he can require for the addressing of his reply; and to preserve a permanent record of the time when the letter was written.

Position.—Upper right-hand corner, immediately below the letterhead if one is used; or where no letterhead appears, at a point not closer than 1 1/4 in. down from the top of the page. So planned that the end of its farthest-reaching member is even with the right-hand vertical alignment of the message below.

Arrangement.—Either with lines successively indented, sometimes called "in echelon" (rather more favored in personal than in business correspondence), an arrangement always preferable with handwritten letters; or in the "block" form, with the left ends of lines in perpendicular alignment, an arrangement more usually followed than not with letters that are typed. The arrangements chosen for the heading should, of course, be followed consistently throughout the letter.

Fullness of detail.—Enough should be included to insure the delivery of the letter without a moment's unnecessary hesitation. The writer should in every case consider what this implies, and then err, if err he feels he must, on the side of undue amplitude.

Punctuation.—Either "closed," that is, with commas after each item save the last, which is followed by a period; or "open," that is, with the omission of all commas at line ends, and of the period after the last item save where this is called for by abbreviation. The closed style is usual among business houses able to employ a clerical force competent to attend to such details. The English custom of placing a comma after the house number—"36, Baker Street"—is not followed in this country. It may be noted that these commas are explainable as due to ellipses of "in" and "on."

Abbreviation.—Always figure a street number. Figure also street names over 100, in this case separating the street name from the preceding house number by a dash. Spell

out street names below 100, or at least such of them as are uncompounded, save where a direction word, such as "South" or "West" intervenes between them and preceding house numbers. Usage generally favors the writing out, rather than the abbreviating, of such direction words. The ordinal signs st, nd, etc., following figured street names are better omitted; where they are used, they take no following period. Where the item is not unduly long, the unabbreviated form of "street" is preferred. Names of cities are not abbreviated at all; and state names only in the manner approved by the postal authorities. This list of official abbreviations is obtainable at any postoffice. Pains should be taken in the verifying of the date, as this item may become a matter of importance. The ordinal signs are better omitted after the day of the month. The year should be indicated in the full figured form.

III. The Direction, or Inside Address

Content.—(4 g) Honorary title, (h) name of the addressee, (i) his position, Note.—Position may, if over long, come below the name,
(5 j) Street number, (k) street address,
(6 l) Town or city, (m) state.

Purpose.—To greet formally the person or persons addressed; and to facilitate the delivery of the letter in case of mistake or mischance in the matter of the superscription.

Position.—On the left-hand border from ½ in. to 2 in., —in general about an inch, below the lower line of the heading. This border averages from 1¼ in. to 2 in. from the left edge of the paper.

In informal letters where the name of a close acquaintance occurs in the salutation, the direction is sometimes moved entire to a position on the left-hand margin immediately below the signature.

Arrangement.—In alignment corresponding to that of the heading; with lines kept of reasonably equal length.

Fullness of detail.—Sufficient to insure immediate delivery.

Punctuation.—Either closed or open, according to what was used in the heading. All names should be written and punctuated in the manner approved by the practice of those they designate. A comma should set off a name from a title following it.

4 g.—Some word of address should as a general rule precede the name; either *Mr., Mrs.,* or *Miss;* or a professional or honorary title; or the plural *Messrs.* (= *Messieurs*), used in addressing firms operating under a name suggestive of the individuals composing it; or the word *The* used before firm names of an impersonal character, save where this article is pointedly omitted from such firm name. *Misses* and *Mesdames* (abbreviated, *Mlles.* for *Mesdemoiselles* and *Mdmes.* or *Mmes.*) are the feminine forms of the plural. The titles *Professor,* the *Reverend, Governor, General,* the *Honorable,* etc., are abbreviated only when a given name or initials occur between them and the surname.

4 h.—The given name or initials should always appear in the direction, and should be given the form used by the bearer.

4 i.—Such designations as *President of* or *Superintendent of*—properly come after professional titles, and are frequently best relegated to the line below 4h, even at the cost of four lines in the direction.

5 and 6.—See points 1 and 2 under the heading.

Interplant or interdepartmental letters may well follow a semimilitary form, wherein (1) the heading and the direction together are accorded the entire upper third of the sheet,—the latter taking the form:

FROM: ....
TO: ....
SUBJECT: ....,

with single spacing within, and double spacing between, these items—the second of which may be blocked as in ordinary letters; wherein (2) the salutation and complimentary close are both dispensed with; and wherein (3) the message, occupying the lower two thirds of the sheet and severely restricted to the discussion of one single topic (More than one letter may, of course, be sent in the same envelope), is

single spaced with double spacing between the paragraphs, which are all numbered. Such a letter is conventionally folded *Z*-fashion, in thirds (which divisions may even be indicated by printed marks on the stationery), with the upper third folded back; that is, with the top and bottom thirds facing upwards, and the middle one downwards.

IV. The Salutation

Content.—*Dear Sir, Dear Madam, Gentlemen, Ladies, Dear Professor, Dear Mr. Smith,* etc. Never *Dear Sirs, Gents, Dear Prof.;* rarely, *Sir.* The preceding of *dear* by the pronoun *My* is used only when addressing acquaintances, and then to suggest some significant departure from the ordinary mood of business either in the direction of cordiality or of extreme formality.

Purpose.—To suggest the exact mood and relation assumed by the writer in addressing his correspondent.

Position.—Flush with the left border; in handwritten letters on the line below the last line of the direction; in typewritten letters, on the second line below.

Punctuation.—Regularly a colon without any following dash.

Capitalization.—The first word and the noun of address are capitalized, but not the adjectives.

V. Special Direction

On the exceptional occasions when this feature is required, it may best be entered on the line with the salutation; this obviates the necessity of another broken line. It may well take the form *Attention Mr. George Smith.* Occasionally one sees printed in the letterhead above the place of the heading the words

Please reply
Attention of..............

In such case, this special direction is the proper form to use.

VI. Subject of Communication

Content.—The Latin word RE, "in the matter of," or the word SUBJECT, followed in either case by a colon and the briefest possible notation descriptive of the message.

Position.—Always, to the right of the salutation. Where a special direction is also desirable, the latter is moved up to the right side of the first line of the direction.

VII. The Message

Content.—In business letters, a clear succinct, well-organized statement of the facts bearing on a single topic. In the first sentence refer to the subject to be considered; mention the previous correspondence here continued; make explicit the object of this communication. Continue without waste of words to say the few pertinent, all-essential things demanding to be said. Close smoothly and roundly with the most telling fact and the finest phrase.

The pronoun most in evidence should be "you," not "I"; this means, maintain the "you attitude" throughout. Undeviating courtesy and consideration should attend the expression from first to last. Social letters, as we all know, should breathe only the atmosphere of the second person; and to catch something of this without passing from formality into colloquialism is the ideal of business letters also.

Position.—Beginning in handwritten letters on the line below the salutation, and in typewritten letters on the second line below; in both cases at the regular paragraph point of indention; and continuing between margins averaging from 1¼ to 2 in. from the left edge of the paper, and between 1¼ and 1¾ in. from the right-hand edge of the paper, the width, of course, depending upon the space required by the message. Care should be taken to avoid a ragged margin on the right.

Arrangement.—Typewritten letters, save when very short, are single-spaced, with a line omitted (i.e., "double spaced") between paragraphs; and, far more often than not, with the usual paragraph indention of from ½ in. to 1¼ in. from the left-hand border or margin (i.e., 5 or 10

spaces). This is irrespective of whether the letter is in the block form or not.

The message should be couched in short paragraphs, ordinarily of two, three, or four typewritten lines, and only in excéptional cases running to seven or eight lines. Where avoidable, the carrying over of a paragraph to a second page should not occur. If at all possible, restrict the letter to one page (save for inclosures); better write it over nine times than go to a third page. Under no circumstances should one conclude at the very top of a new sheet. Every composition passed in to one of the author's former instructors, he well remembers, was required to end on the right-hand margin of the last line on the page. It can be done.

Sometimes the message can be closed effectively with a continuant note of interest, anticipation, or personal good will; such, for example as, *Awaiting your reply, I am; With best wishes, we are; With sincerest appreciation of these favors, we remain.* Although purely optional, such a phrase, if it can escape all suggestion of the stereotyped, adds a happy suggestion of personal contact, and as such is to be valued. In a first letter, *I am* is properly used; in succeeding correspondence, *I remain,* regularly takes its place. Admittedly but the vestigial remains of such eighteenth-century honorifics as, "I have, sir, the honor of being, ever with sentiments of profoundest consideration, your humble, obedient, and faithful servant,—Joseph Addison, or whoever else happened to be writing, such expressions like any other courtesy may serve to relieve somewhat the jolts of life.

VIII. The Complimentary Close

Content.—The word *yours,* always; together with an adverb, or much more rarely, a prepositional phrase;—*Yours very truly,* or *Yours for the brightest future.* The former of these, or the slightly more common *Very truly yours,* is never inappropriate. *Yours truly* is considerably more curt and lacking in sentiment of any sort; *Yours sincerely* and *Yours cordially* show two steps of progress in the direction of friendliness and feeling. *Respectfully* (not

VI. Subject of Communication

Content.—The Latin word RE, "in the matter of," or the word SUBJECT, followed in either case by a colon and the briefest possible notation descriptive of the message.

Position.—Always, to the right of the salutation. Where a special direction is also desirable, the latter is moved up to the right side of the first line of the direction.

VII. The Message

Content.—In business letters, a clear succinct, well-organized statement of the facts bearing on a single topic. In the first sentence refer to the subject to be considered; mention the previous correspondence here continued; make explicit the object of this communication. Continue without waste of words to say the few pertinent, all-essential things demanding to be said. Close smoothly and roundly with the most telling fact and the finest phrase.

The pronoun most in evidence should be "you," not "I"; this means, maintain the "you attitude" throughout. Undeviating courtesy and consideration should attend the expression from first to last. Social letters, as we all know, should breathe only the atmosphere of the second person; and to catch something of this without passing from formality into colloquialism is the ideal of business letters also.

Position.—Beginning in handwritten letters on the line below the salutation, and in typewritten letters on the second line below; in both cases at the regular paragraph point of indention; and continuing between margins averaging from 1¼ to 2 in. from the left edge of the paper, and between 1¼ and 1¾ in. from the right-hand edge of the paper, the width, of course, depending upon the space required by the message. Care should be taken to avoid a ragged margin on the right.

Arrangement.—Typewritten letters, save when very short, are single-spaced, with a line omitted (i.e., "double spaced") between paragraphs; and, far more often than not, with the usual paragraph indention of from ½ in. to 1¼ in. from the left-hand border or margin (i.e., 5 or 10

spaces). This is irrespective of whether the letter is in the block form or not.

The message should be couched in short paragraphs, ordinarily of two, three, or four typewritten lines, and only in exceptional cases running to seven or eight lines. Where avoidable, the carrying over of a paragraph to a second page should not occur. If at all possible, restrict the letter to one page (save for inclosures); better write it over nine times than go to a third page. Under no circumstances should one conclude at the very top of a new sheet. Every composition passed in to one of the author's former instructors, he well remembers, was required to end on the right-hand margin of the last line on the page. It can be done.

Sometimes the message can be closed effectively with a continuant note of interest, anticipation, or personal good will; such, for example as, *Awaiting your reply, I am; With best wishes, we are; With sincerest appreciation of these favors, we remain.* Although purely optional, such a phrase, if it can escape all suggestion of the stereotyped, adds a happy suggestion of personal contact, and as such is to be valued. In a first letter, *I am* is properly used; in succeeding correspondence, *I remain,* regularly takes its place. Admittedly but the vestigial remains of such eighteenth-century honorifics as, "I have, sir, the honor of being, ever with sentiments of profoundest consideration, your humble, obedient, and faithful servant,—Joseph Addison, or whoever else happened to be writing, such expressions like any other courtesy may serve to relieve somewhat the jolts of life.

VIII. The Complimentary Close

Content.—The word *yours,* always; together with an adverb, or much more rarely, a prepositional phrase;—*Yours very truly,* or *Yours for the brightest future.* The former of these, or the slightly more common *Very truly yours,* is never inappropriate. *Yours truly* is considerably more curt and lacking in sentiment of any sort; *Yours sincerely* and *Yours cordially* show two steps of progress in the direction of friendliness and feeling. *Respectfully* (not

respectively!) *yours* is properly used only where recognition is accorded dignity, position, or authority. *Respectfully submitted* sometimes used at the close of a report is well-nigh the only exception to our first statement in this section.

Purpose.—To add a courteous note, and a fitting touch of finality to the communication; and at the same time to indicate the relation existing between the correspondents.

Position.—In handwritten letters, on the line below the conclusion of the message, and slightly to the left of the middle line of the sheet; in typed letters, on the second line below the message, and some ¼ in. either to the left or right of the middle of the sheet, depending on the length and general weight of the signature.

Punctuation.—Even where open punctuation is used in the heading and direction, a comma is likely to appear after the complimentary close. Where the more usual closed punctuation obtains, this comma always appears.

Capitalization.—On the first word only.

IX. The Signature

Content.—The legible penwritten name of the person sending the message. With this may appear the name of the concern for whom he signs, or with whom he is associated, and also a notation regarding the position he occupied and the department with which he is connected. Whenever letters are dictated, further notation appears, indicative of the stenographer who typed the letter; and in the event that the name of the sender is not affixed by his own hand, the initials likewise beneath this name of the duly authorized person who performed this service. The signature should include at least one given name. An unmarried woman prefixes *Miss* to her given name, unless she happens to be a person in a regular executive position. A married woman signs her given name before her name by marriage, and below this in parentheses she places her husband's name preceded by *Mrs.* A widow signs her given name before her name by marriage prefixing the word *Mrs.* in parentheses.

Purpose.—A permanent record as to who wrote the letter; a rendering authoritative and legal, as by a seal, whatever is contained in the message.

Position.—Beginning at a point two spaces below and slightly to the right of the beginning of the complimentary close.

Arrangement.—Dependent upon what is included. If the signature consists merely of the name of a single individual, the case is clear; but often this is not the situation. It may be followed by its own typed repetition (a device which insures the name of the writer on the carbon copy); it may add to the name the position of the writer, or the department in which he is employed,—possibly, even of both of these. When a person signs his own name, thus, following the complimentary close, the responsibility for the letter attaches primarily to him, and only secondarily to the firm he represents. More usual in company letters, however, is the indicating of the company's responsibility by a placing of its name, in full capitals, on the first line below the complimentary close (beginning some four spaces to the right of the beginning of the latter), and two spaces to the right of this to align, four lines below, the typed signature of the writer and the name of his department; with his title, if one is to appear, either following the typed name on the same line or preceding the departmental name on the line below. The written signature is later entered in the space left vacant below the capitalized company name. The older usage was to precede the written signature in such cases as this with the word "By," or "Per." Where this signature is entered by another than the dictator of the letter, the agent's initials follow slightly below and to the right.

On the left margin one space below the last line of the signature proper, entered without periods, appear capitalized the initials of the dictator and following them after a hyphen, colon, or a line slanting down and to the left, the initials of the typist (or, sometimes, in large concerns, by her number).

Punctuation.—The only terminal punctuation required in the signature, save for the abbreviations, is a period after the final typed line, with a comma after any typed line that

precedes it. Neither the Company signature nor the written signature requires either a period or a comma after it.

Capitalization.—Aside from the full capitals in the company name, capitals should be used for the main words in titles, and for the main words in departmental designations.

X. Inclosures

Either below or (logically) above the combined initials on the left-hand margin, also on the margin, comes the notation, particularly for the benefit of the mailing clerk, of any inclosures that the letter may contain. These are entered *Incl.* for a single case, or if there be, say three, *Incl.* (*3*).

XI. Superscription

Content.—The outside, or envelope, address contains essentially the same material that appeared in the heading, with the exception of the omission here of any save individual titles.

Position.—The name of the addressee is written through the center of the envelope, evenly balanced above and below and on both sides.

Arrangement.—Either the block on the indented arrangement may be used, according to whichever is used in the letter itself. Each item, designed to catch the eye of a different employee in the Postal Department, is given a separate line; the street or its equivalent on one, the town or city on another, and the state on a third. In exceptional cases the lower left-hand corner may be used for such items as *Care of* (Better, following the name) *Please forward,* or *Personal.*

Punctuation.—No punctuation at line-ends save for abbreviation.

XII. Return Address

Content.—The name of the sender, and beneath this, his address.

Purpose.—This insures the prompt return of the letter if for any reason it cannot be delivered to the addressee.

Position.—In the upper left-hand corner of the envelope.

XIII. Folding, etc.

(1) Fold the bottom edge over to within about ½ in. of the top, and crease, keeping the sides in perfect coincidence. (2) Fold 3 in. on the right over toward the left, keeping the edges straight as before. (3) Fold 2 in. on the left over toward the right overlapping the last fold. (4) Insert in the envelope, wedge side down; that is, with the top of the letter in the stamp, or right-hand, end of the envelope. In folding the paper to fit the long envelope, 4 by 9 in. or 4¼ by 9½ in., double the bottom edge up over 3½ in. and crease; then fold 3⅝ in. of the top down over this, thus making the folded letter 3⅞ in. in width, and avoiding thereby all conflict of edges. Insert wedgeside down as before. (5) Seal. (6) Place sufficient postage in the upper right-hand corner of the envelope; and (7) post.

The general arrangement of the letter appears in the following example:

JOYCE, JORDAN, AND JOSLYN, INC.

W. M. JOYCE		*Chicago*
HENRY JORDAN	Architects and Engineers	142 Grant Bldg.
P. H. JOSLYN	*Civil*	
	Structural	*Milwaukee*
	Hydraulic	526 — 102 St.

1024 Fourth Ave.,
Iowa City, Iowa,
March 19, 1928.

Messrs. J. Morgan and Co.,
43 South 143 Street,
Cedar Rapids, Iowa.

Gentlemen: Subject: River Walls

Two methods suggest themselves for dealing with ....

Yours very truly,

JOYCE, JORDAN, AND JOSLYN, INC.

Wilbur E. Lee
Superintendent, Structural Work.

WEL - AB
Incl. (2)

W. E. Lee
1024 Fourth Ave.
Iowa City, Iowa

J. Morgan and Co.
43 South 143 St.
Cedar Rapids
Iowa

Throughout the letter the writer should confine himself to the presentation of facts. He should give attention to their coordination at every step. The short "quadral" sentence illustrated on pages 57, 285 is strongly to be recommended. Particularly is this true of letters that are dictated. The writer who with rather full notes in hand advances in the presentation of his thought,

through a first,
    and related second, movement,
  then joins these movements
    to a third and fourth,
and brings each sentence
    to its close
  after such a four
    or multiple thereof,
will have little difficulty
    in dictation,
  once the first novelty
    has worn away.

Finally, every letter writer should ponder and ponder again the remark once made by a prominent engineer, "I have written a long letter as I didn't have time to write a short one."

The Letter of Request

The letter requesting some friend or acquaintance, some instructor, or some former employer to write a testimonial to one's character, or general or special ability, we shall consider next. As the tone of this may range from a considerable degree of friendliness and familiarity, to an equally marked degree of formality, so the outward form and makeup of the letter should correspond. It may be proper to handwrite the letter on personal or even on society stationery; it may again be altogether desirable that it be typed and sent on plain bond paper of the regular size. Similarly the direction may or may not be moved from its normal position before the message to a place on the left margin below the signature; and the salutation and complimentary close may be subtly shifted the better to express the writer's sense of his relation to his correspondent. At this point, however, familiarity should cease; the message itself should appear as a business document, written with a serious purpose, and looking to a serious response. In form it should be not only neat and flawless, but positively attractive to the eye. In its setting forth of ideas it should be clear, direct, explicit, altogether intelligible. Its style should be tactful, dignified, well-mannered,—easy withal. Its whole effect, in short, should be one of pertinence and completeness combined with order and the utmost possible conciseness. To this letter, and to the letter of application, one should spare no pains and begrudge no time. The last paragraph may contain a news item, the latest bulletin of the writer's activity or aspirations; and it should end, *not* participially, but with a brief declaration of gratitude and appreciative recognition of any service that may be rendered by the one addressed.

When the letter has been composed, it should be checked for grammar, spelling, punctuation, and tone. The writer does well to bear in mind the fact that simplified spelling appears to many professional men of the older school about as red as, let us say, "proffessor," "privaledge," or "if I am excepted for the position." The omission, once more, of pronominal subjects; the weak, strung-out ending of sentences; the use of "would" for "should" before *like, be glad,*

prefer, enjoy, appreciate, etc., are to many others, he may well remember, most distasteful. Finally, he should cast a critical eye over the makeup of the page; and only after these points have been attended should he sign it—on a straight horizontal line; fold it—neatly; insert it—properly —in the envelope, together with a stamped envelope addressed to himself; seal it—properly; superscribe it; and send it out.

The Letter of Application

The letter of application is regularly typewritten on one or two sheets of plain bond paper of good quality, 8½ by 11 in. in dimension. It is composed in full form and does well to bear at the right of the salutation the item "SUBJECT: Employment."

This letter should be conservative without being stereotyped; and eminently personal without being affected on the one hand, or on the other offensively self-assertive. The writer in tendering his services to potential employers, may well apply in it the entire argumentative technique, and lead up through preliminary information through items calculated to promote conviction and persuasion to the stimulating if possible of action in line with his interests.

Let us, then, consider it in the light of the time-honored divisions of formal argument: The introduction with its origin of the question and establishment of contact with those addressed, with its definition, its narration, and its statement of the issues; the body with its twofold or threefold confirmation of the point urged for acceptance; and the conclusion summarizing the evidence and paving the way for action. Together these form a fabric of details mutually supporting and cumulative in effect. Each point should be paragraphed by itself, and should be set forth with all the conciseness that is consistent with accuracy and completeness.

First of all should come a statement, positively, yet not too bluntly, phrased, to the effect that this is an application for employment. Do not refer to yourself in the third person as "the writer," but as "I"; do not "offer your services"; do not inquire whether or not a position is vacant. State

that you write in answer to some advertisement, if this be the case, and which one; or that you write on the advice or suggestion or information of a friend, if this be the case; or it may be, because of your own particular interest in the line of work carried on by the company addressed. Next comes definition, in which you state explicitly just what you desire, whether immediate employment, or employment at some future time either specified or not. Here, also, you do well to indicate as exactly as possible the particular sort or sorts of work for which you are making application. Already, if these matters are rightly handled, you will have aroused the interest of your reader, and impressed him with the fact that you are one who knows what he wants to do, who has some definite acquaintance with the requirements of the position, and who by his powers of succinct expression has given evidence of his ability to handle efficiently whatever the place requires of him.

This interest leads naturally to curiosity to know more of the applicant; and to satisfy this curiosity you include a brief history of what you have done. This may embrace the briefest statement of age, marital state, and constitution; it will surely touch on your education and on your experience. Secondary schooling may well be mentioned if it was carried on under exceptionally favorable circumstances; collegiate courses and technical training both undergraduate and graduate naturally demand more attention. Conciseness need not prevent you from mentioning any special courses taken or particular studies made during this period of training. The statement of experience should be full and definite, and of a nature to indicate that you may be expected to know certain things, by reason of the fact that already you have done them. It should note whether employment has been continuous, or during vacations only; it should indicate the length of such period of employment, the place and character of the work, and the particular capacity in which you were engaged. To mention your immediate superior or superiors is also always in order.

In view of the fact that in an early stage in one's career one's experience is necessarily limited, these last notes may frequently, and without prejudice to the candidate for em-

ployment, be brief. Where this is the case, wisdom recommends a discreet silence rather than the gratuitous statement that you are practically without experience, or that such slight experience as you may have had was of little worth. Value lies in what a thing is,—in what it can do; never in what it is not,—in what it cannot or has not done.

This, following the outline of debate, brings us to the "issues," to the question of whether to act favorably, or unfavorably, on your appeal. Here, the not unponderable element of personality should be thrown into the scale. Prevent the question, by an assertion; answer the question ere fairly it is asked, with a positive statement, with a declaration of fact. Evince your belief that on the evidence presented, supported by your natural aptitude, you cannot but succeed. Express such interest as you have in the work applied for, as supplementary evidence of qualifications along that line. The note of confidence at this point may well assure the reader that you have something in you beyond the mere ability to pass courses and perform a routine task. Personality and character, self-assertiveness and self-dependence,—these are qualities for which employers are always in the market. The further intimation that you regard the prospective position as an opportunity for the expression of the best that is in you, can hardly fail to strengthen the carrying power of what you write.

But all this assertion calls for proof, for some verification and substantiation. Persuasion must be supported by conviction, and conviction looks to further testimony. This is supplied in the mention of the names of men who are presumably sponsors of your application,—of persons who as "references" have apparently consented to vouch for your character and ability. These should be selected with a view to indicating the various aspects of your accomplishment. One may be in a position to know your standing in your home town; another, your collegiate record; and a third, your record in employment. Indicate always that you are permitted to make mention of these guarantors. Present with their names their titles or positions, and their full addresses,—all in tabular form with successive indention of the several items.

This brings us to the conclusion. You have presented your general and specific qualifications; you have suggested your assets of personality and character. Now you want to secure some favorable move on the part of your correspondent. Would he like—would he *not* like—more detailed information, a photograph, samples of your work,—best of all, where conditions make this at all practicable, an interview,—a conference, at a time at once possible for you and convenient to him?

Once more indicate your belief in the sufficiency of your educational and professional qualifications and of your particular adaptability for the work applied for; indicate declaratively—not with any participial introduction—the expectancy with which you await reply, and close.

Check over this letter, criticize it, see that its every detail of form and tone is an argument accrediting you to favorable consideration. Note whether the very "feel" of the letter, its finish, its folding, its face of type, make it a thing to be admired, and treated, as it were for its mere appearance sake, with consideration;—a thing to be refused, if refused it must be, only with regret. Remember that a good piece of work in the present is the best earnest in the world of good work yet to come. Do not discount the fact that in the eyes of many an employer a perfect letter is one of the highest possible forms of recommendation. Remember again that while you may easily write below your ability, you are not likely actually to outdo yourself; and that many professional authors in attempting to reach their highest pitch have written and rewritten certain of their passages five, ten, even fifteen times. So do not disparage the value of revision;—more particularly of that revision which is guided by the listening ear.

For further information regarding correspondence, more especially the other forms of letters, the student is directed to the excellent manuals dealing specifically with this subject. Among those particularly helpful he will find the following.

CHAPTER X

SPELLING

A basis of fact underlies the many hard things said about the spelling of the English language. It is the handiwork of a peculiar people. Little by little, its vocabulary has been picked up, during the period of a dozen centuries, in every quarter of the globe. Throughout its history it has been a living, growing, changing language. Its chief sources of derivation have likewise been changing as to their own orthography. At the start, it was written and spoken in several dialects; of late, it has undergone contemporary development in many an overseas nation and dominion. As a result, discrepancies in its spelling are not surprising; they are inevitable. Although to account for its anomalies of spelling is not quite the same as to overcome them, it may quite easily prove a material step in that direction.

Success in spelling is attained only by persistent and well-directed effort. After reviewing the entire situation in the *Eighteenth Yearbook* of the National Society for the Study of Education, Part II, p. 53, Dr. Ernest Horn concludes in a word: "The first need is the recognition *that there is no short cut to spelling.*" The natural-born speller is, to all intents and purposes, nonexistent. That is not to say, however, that we have no good spellers. Some have encountered and overcome the difficulties earlier; some, later. The aim of the following sections is to aid still others to overcome them, by pointing out certain stumbling blocks,—their nature and extent, in some cases, also, their origin; and by indicating certain methods of coping with these difficulties.

In the last connection, a few observations of a general nature may not be out of place. Nine tenths of the errors made in spelling, as appears from an article by Prof. William T. Foster, "The Spelling of College Students" (*Journal*

of Educational Psychology, 1911, p. 213, Warwick & York, Inc.), in which he tabulated 2005 errors in 10,000 themes, are due to half a dozen causes. His figures follow:

1. Carelessness 467 (intelgent, crunb, an "and").
2. Mispronunciation 259 (atheletics, goverment, seperate, suprise, dormatory).
3. Insertion of silent letters 388 (amoung, deffinition, occassion, charachter, proffession, harmfull, comming, schould).
4. Omission of silent letters 465 (begining—26 times, necesary, condem, thot, releas, knoledge).
5. Order of *ie* and *ei* 31.
6. Confusion of *-al* and *-le* 33.
7. Confusion of *-ent* and *-ant* 24.
8. Confusion of *-se*, *-ce*, *-ze* 44.
9. Confusion of *-able*, *-ible*, *-ance*, *-ence* 28.
10. Spelling *-er* sound as pronounced 167.
11. Due to all other causes, including doubtful cases 99

2005

These common errors should be thoroughly understood with a view to making upon them a definite, systematic, determined attack. No aimless, haphazard fits and starts of good resolution will bring results. The following recommendations may prove of assistance in planning this campaign. First, survey the field to discover what types of words are by you most liable to be misspelled. Then, study these groups in order, scrutinizing the words of each critically—with a will to see. Eliminate the easy part, and center attention upon the hard part;—that is to say, concentrate on the difficulty. Visualize the word wrong and right, and know which is which. Do not despise "rules" despite the scepticism of educational psychologists regarding their value. Study the type, and wherever possible find a statement to cover the formula of the type. Then you will know, not only, why *equipping* has two *p's* and *equipment* only one, but when and why to double and refrain from doubling letters in several hundred other words. To facilitate remembering, visualize groups of puzzling cognates together, underlining or blacking-in their special difficulties. If you are of the ear-minded folk, spell aloud and pronounce with attention on each *-ance* or *-ence*, or whatever the per-

plexing syllable may be. As you pronounce, locate silent letters and mark carefully single and double letters. Observe their respective priority in words such as o*cc*a*s*ion, r*ecomm*end, a*ccomm*odate. If on trial it proves helpful, shut your eyes and write down the old offender a dozen times or so. Whatever your method, supplement drill by review, and re-review at intervals the lesson of a week or a month before. At length your mind will leap gladly forward at the point where formerly it faltered; and habit will fix the form which reason and memory learned so slowly at the start. You should not forget to use in your spelling whatever knowledge of the classic languages you may have. If you are sufficiently advanced, you will find such a knowledge of etymology of considerable assistance. Derivation is a main prop both to definition and to spelling. In the case of many words such as *except* and *accept, council* and *counsel,* a clear differentiation of meaning is indispensable. Finally you should develop the dictionary habit; have a copy always within reach of your desk in a man's-size up-to-date edition, and add to your list for review every word you have occasion to look up.

Max Müller is reported to have said that a child who would believe all he is taught in learning to spell the English language, might be trusted thereafter to believe anything. Probably true; still let us not be discouraged. Let each person select the method best approved to his own reason. Let him study his own case, locate his peculiar failings, welcome advice, experiment with such suggestions as bid fair to meet his needs; and then settle down to give to whatever course promises most success a fair trial. When he finds, upon such trial, that he still can't spell; why, in this as in everything else, the only thing for him to do is to give it up,—and in this case join the great company that no man can number of simplified spellers.

Preferred Spellings

In their spelling of a great many words the American dictionaries, *Webster, Standard,* and *Century,* are at variance with one another and often they are all of them at

odds with the English authorities. The words in the following list all have such variant forms less well supported than those that appear:

adz, aline (align, *Webster*), alkali, aluminium, analyze, apprise (to notify), apprize (to value), ashlar, colander, controller, connection, creosote, curb, dike, disk, draft, drier, felly, filigree, foundry, frustum, gage, gram, gray, hypotenuse, jetty, license, mandrel, Manila, maneuver, mold, naphtha, ocher, offense, peavey, pipette, pincers, plot, pretense, reconnaissance, reenforce, scow, siphon, skilful, slaked, smolder, stanch, story, sulphate, sulphur, sump, swage, taut, templet (template, *Webster*), toward, trolley, tunneler, tuyere, usable, vial, veranda, vise (instrument), vizor (visor, *Webster*), wagon, wainscoting, weir, woolen, zinc.

Troublesome combinations

Some words are difficult to spell because of awkward sequences of letters,—knots of consonants, or slithery sequences of vowels; at other times, length itself, especially where the syllabic division is not obvious, may render the poor speller panicky while yet the word has a third of its length to go. Such difficult words are,

aisle, apse, chasm, crypt, niche, quay, queue, rhythm, scythe, sphinx, twelfth, yacht, caoutchouc, catarrh, crystal, khaki, oblique, opaque, schedule, diaphragm, diphtheria, exorbitant, hemorrhage, molybdenum, synonym, aerohydrodynamically, anonymity, electrolytically, hydrometeorological, idiosyncrasy, triakisicosahedron, dihydroxydilolylmethane, hydroparacoumaric, p-hydroxy-B-phenylpropion-ic (acid).

Those who agree with the poet that

"Trinitrotoluol looks pretty rough
Either in prose or in verse,"

should be thankful that they did not live in Germany some decades ago, where school spellers listed such words as

obervormundschaftscassenbestand, parükenmacherzunftgebräuche, katechismuswiederholungsstunde, *u. s. w.*!

or even in that southern country of verbal music where Dante, the father of Italian letters, favored with his authority.

onorificabilitudinitate and sovramagnificentissimamente.

Many foreign words are rendered difficult by unfamiliar combinations of letters, for example:

avoirdupois, clientele, connoisseur, liaison, maneuver, papier-mache, ricochet, silhouette.

Ambiguous sounds

Many unaccented syllables in English are leveled to an obscure sound lying between *e* and *a* and oftentimes suggesting the spelling *er.* Distinct enunciation will here help, along with a careful visualization of the weak syllable. Examples are:

A.—comparative, customary, dilatory, equivalent, formally, preparation, prevalent, reparable, representative, secretary, separate, apparatus.
E.—malleable, temperature, variegate, beneficial, carburetor, descriptive, operate, refrigerator, vaseline, complement, repetition, stupefy, supplement, maintenance.
I.—agitate, aniline, comparison, definite, dormitory, eliminate, infinite, iridescent, irrigate, orifice, pediment, precipice, division, privilege, sediment, prominent, dirigible, auxiliary, municipal, miniature.
O.—accessory, accommodate, analogous, corroborate, laboratory, perforate, refractory.
U.—corduroy, pendulum, carburetor.
Y.—acetylene, anonymous, labyrinth, synonymity.

Doubled letters

Some words are rendered difficult to spell by the presence in them of doubled letters; others, by the fact that letters that sound double prove to be single. Among the most troublesome of these are the following:

Aggravate, correspondent, opportunity, symmetry.
accelerate, aggregate, apparatus, correlation, corroborate, exaggerate, occasion.
accessible, accommodate, committee, embarrassment, occurrence, reconnaissance.
across, capillary, colonnade, corollary, disappear, disappoint, emission, necessary, parallel, professor, recommend, demurrage, desiccate, omission, Philippine.
acquittal, canvass, finally, formally, generally, miscellaneous, personnel, questionnaire.
already, altogether, always, apartment, corespondent, councilor, counselor, operate, procedure, until.

Note that Webster differs from certain other dictionaries in doubling the *l* in the words *distil, enrolment, fulfil, fulness, instalment, instil, skilful,* and *wilful.*

-able, -ible.

A large group of adjectives in English conveying the idea "of a nature to be —ed" are formed by the addition of the suffixes *-able, -ible,* or *-ble* to the stems of verbs, or, less frequently, of nouns. From these adjectives, in turn, adverbs and nouns are made, the former by changing the final *-ble* to *-bly;* and the latter, by changing the *-ble* to *-bility* and *-bleness;* e.g.,

avoidable	avoidably	avoid-ability	avoid-ableness
flexible	flex-ibly	flex-ibility	flex-ibleness
soluble	solu-bly	solu-bility	solu-bleness

In the spelling of these words, confusion has arisen, owing to the fact that in coming over from the original Latin into English some of the older words in this list underwent a change in the intermediate Old French stage of their development, whereas other more recent borrowings came from Latin directly, or through Modern French, without suffering any change from the original form. In Late Latin or Old French (A.D. 600–800), Latin conjugational stems in *-a, -e,* and *-i* were leveled to the most common form of the three, the *-a* type of the first conjugation. Having become accustomed to this ending, and having found it exceedingly useful, English has gone ahead to add it to any and all verbs. A confusion of the Latin suffix *-able* (Latin *-abilis*) with the independent English adjective *able* (Latin *habilis,* "handy," from *habere,* "to hold"), has led to a general preferring of the *-able* form to the one in *-ible.* Thus the latter ending is largely confined to late, consequently rather abstruse, words, coming from Latin *e-* and *i*-conjugations largely through the French.

A few further notes regarding this group may not be out of place:

1. A final *-e* before the suffix is generally dropped: (*move, mov-able; conceive, conceiv-able; sense, sens-ible; response, respons-ible*). Exceptions, however, occur in the two following cases:

a. This palatal vowel, *e*, is retained to indicate the soft ("front," or palatal, as distinguished from the "back," or guttural, sound of *c* and *g* before the guttural vowel *a* (*enforc-e-able; chang-e-able*). Since *i* is a palatal vowel itself, the *e* is dropped before the *-ible* ending, giving us *force-ible* and *neglig-ible*. (Note the change from soft to hard in *practice, practic-able*.)

b. This *e* is retained in certain variant spellings to preserve the length of long vowels in the preceding syllable (*blame-able*[2], *blam-able*[1]; *sale-able*[2], *sal-able*[1]; *like-able*[2], *lik-able*[1]; *name-able*[2], *nam-able*[1]).

2. Words ending in double *e* retain both *e*'s before the suffix (*agree-able*).
3. The falling of the accent on the final syllable of a word ending in a single consonant, preceded by a single vowel, results regularly in the doubling of that consonant (*control, control-l-able; regret, regret-t-able*);—except, that compounds of *-fer* do not double the *r* (*infer-able, refer-able, transfer-able*, and *x* (= ks) is not double- (*tax-able*). Note that *inflammable* is not derived from *inflame*, but from Latin *flamma*, through the French *inflammable*.
4. Final *-y* is changed to *-i* before *-able*. (*classify, classif-i-able*).
5. Certain words in *-ter* suffer a loss of the *e* (*administer, administrable; register, registrable*).
6. Final *-t* changes to *-s-* in such words as *admit, admissible; omit, omissible; permit, permissible*.
7. Variants in *-able* and *-ible* occur in the case of *admittable*[1] (cf. *admissible*), *addible*[1], *ascendable*[1], *condensable*[1], *defensible*,[1] *descendible*[1], *enforceable*[1], *inferable*[1], *immersable*[1], *referrable*[1], *negligible* (French *negligeable*). Note differences of meaning in *impassable* and *impassible*.

Examples illustrating the tendencies in this group of words are the following:

applicable, communicable, irrevocable, effaceable, replaceable, serviceable, forcible, reducible, producible, avoidable, dependable, expandable, audible, credible, subtendible, agreeable, sizable, salable, peaceable, malleable, permeable, indefatigable, irrigable, navigable, allegeable, arrangeable, exchangeable, changeable, dredgeable, gageable, derigible, tangible, (il)legible, available, isolable, (in)delible, (in)fallible, terminable, discernible.

More difficulty is encountered in the case of words whose stems end in *s*. Certain of these we shall list under the main vowel sound, as follows:

-able		*-ible*
apprais-, eras-, purchas-	ā	persuas-
releas-	ē	((in)de)feas-,
advis-, revis-	ī	
dispos-	ō	explos-
excus-	ū	((in)de)fus-
travers-, convers-	ẽ	immers-, submers-,
endors-	ô	exhaust-, plans-
class-, pass-	ă	collaps-, expans-
assess-	ĕ	acces-, compress-, express-, impress-, repress-
(in)dispens-		apprehens-, comprehens-, defens-, distens-, extens-, ostens-, reprehens-, sens-, tens-
	ĭ	admiss-, divis-, omiss-, permiss-, transmis-, vis-
	ŏ	poss-

Stems ending in *t* are probably the most difficult of all to account for; for example:

cultivat-, break	ā	
beat	ē	compet-(see ĕ.)
excit-, indict-	ī	ignit-
port-, pot-	ō	
attribut-, indisput-, reput-, suit-	ū	
	ẽ	controvert-, convert-, revert-
comfort-	ô	exhaust-
surmount-	ou	
	ȧ	part-
adapt-, tract-, tax-	ă	compat-, contract-
forget-, market-, regret-	ĕ	compet-
accept-		percept-, recept-, suscept-
(in)content-		(in)digest-
detect-, respect-		effect-, perfect-
prevent-		contempt-, invent-
admit-, credit-, equit-, indomit-, indubit-, inevit- irrit-, profit-	ĭ	resist-
adjust-	ŭ	combust-, conduct-, corrupt- destruct-

-ify, -efy.

Many English verbs show an ending *-ify* from Latin *-ficare* (*facere*, "to make," or "to turn into"), through

French *fier;* and have corresponding to them nouns in *-fication* (*qualify, qualification*). Examples are,

beautify, classify, electrify, gasify (by analogy), qualify, rectify, petrify, solidify (by analogy), specify, typify (by analogy).

Alongside these occur a few derivatives of *-facere* (though not from an *i*-stem) and *-fier* that end in *-fy*, with nouns in *-faction;* for example:

labefy, liquefy, putrefy, rarefy, rubefy, stupefy, tepefy, torrefy, tumefy.

-ei-, -ie-.

These little letters have proved a perennial source of confusion to young writers. We arrange a few examples according to sound, in the hope that this may help to overcome certain of the difficulties:

ē—achieve, apiece, believe, frieze, lien, pier, tier, yield, either, inveigle, leisure, seize, weir, Reid, ceiling, conceive, perceive, receipt, receive.
ĕ—proteid, protein; hygiene, lieu, heifer, nonpareil, Leicester, Seidlitz.
ī—gneiss, height, kaleidoscope, seismograph, spiegeleisen, Fahrenheit, Reilly.
ĭ—mischief, sieve,
counterfeit, forfeit, mullein, surfeit, vermeil.
ā—eight, foreign, freight, neighborhood, seiche, sein, vein, weigh.
ū—lieu, lieutenant.

We assume that little difficulty will be caused by such two-syllable pronounciations as we have in *fiery, society, gaseity, homogeneity,* and the like.

in-, en-.

Many English prefixes continue the Latin *in-* or its French derivative *en-*, which latter before *b, p,* and *m* becomes *em*. In not a few cases (*encroach*[1], *inclose*[1], *infold*[1]) the choice between the forms can scarcely be said to be established. Favored spellings, however, appear to be the following:

embarrass, embed, emboss, embody, embrace, enact, encircle, encompass, encroach, encumber, engrain, engrave, engulf, enjoin, enroll, entrust, entwine,
imbibe, imbrue, incase, inclose, incumber, indorse, ingraft, inquire, inscribe, install, insure, intrust, intrench.

-ine, -in, ene; -ide, -id; ite.

The student of chemistry or mineralogy who has occasion to use these terms from Latin *-inus* and *-enus* (Greek -ινος and -ενος) should look them up in the *New English Dictionary,* Webster's *New International Dictionary,* the *Century Dictionary,* and the *Standard Dictionary.*

-ice, -ise, -ize.

The most usual sources of words in *-ice* and *-ise* is the Latin suffix adjectival suffic *-itius,* "the condition of." These words became in Old French *-ise,* or *-ice;* in Modern French, *-ice.* Middle English, of course, followed the older French; Modern English, the later. Confusion is the result. These words are mainly nouns and verbs (Cf. *nice, precise, concise*) ; with few exceptions they have the vowel sounds heard in *miss, mice,* and *miser.* Most nouns with the ĭ-sound are in *-ice;* for example,

accomplice, apprentice, armistice, artifice, cornice, crevice, edifice, interstice, lattice, matrice, notice, orifice, practice (earlier *-ise*), precipice, pumice, service.

Among the exceptions are,

mortise, premise, promise, and treatise.

The verbs with this sound, with a few exceptions (*practise*), follow the spelling of the nouns. Most nouns with the ī-sound show the spelling *-ice* (Note, however, *cowardise*); e.g., *advice* (earlier *-ise*), *device* (earlier *-ise*), *price, sacrifice, slice, splice.* The corresponding verbs, including such others as *entice* and *suffice,* follow the spelling of the nouns.

Nouns having the sound *-iz,* and also verbs take the spelling *-ise;* for example,

disguise, enterprise, exercise, franchise, guise, merchandise; advertise, advise, apprise, comprise, compromise, despise, devise, disguise, exercise, improvise, incise, premise, revise, surmise, supervise, surprise.

Passing over now such exceptional sounds as we see in *choice, voice, police, caprice, juice, sluice, appraise* and *praise,* we come to another set of words with the iz-sound; this time, verbs, regularly from Greek -ιζειν through Latin *-izare,* and French *-iser* ("to treat like," or "to make like"),

but supplemented by endless forms of modern, non-classical derivation; for example:

> **authorize, burnettize, carbonize, centralize, characterize, crystallize, economize, emphasize, equalize, geologize, generalize, italicize, legalize, localize, etc., etc.**

Participles in -ing and -ed.

The spelling of present and past participles depends first on the number of syllables; and second, on the character of the final letters.

Monosyllabic strong verbs modify the vowel (*run, ran; sit, sat*); monosyllabic weak verbs ending in two consonants add *-ing* or *-ed* without further change. Monosyllabic weak verbs (1) ending in one consonant, (2) preceded by one vowel, double this consonant before *-ing* or *-ed*. Note, however, that final *w* is not doubled, and that a *k* is inserted after final *c* to preserve the hard sound (*hew, hewed; zinc, zincking, zincked*). Regular examples are, *bid, bid-d-ing; cut, cut-t-ing.*

Monosyllabic verbs ending in one consonant preceded by two vowels add *-ing* and *-ed* directly; e.g., *floor, flooring, floored.* So also *beat, keep, scoop, lead, tear,* etc., save, of course, where the past participle shows the strong form, as *led, torn.*

Monosyllabic verbs ending in a single *f* change this letter to *v* (*half, halving;* cf., *stuff, stuffing*); those ending in *y* preceded by a consonant, retain the *y* in the present participle (*dry, drying*), but in the past change it to *i* (*dried*); those ending in *y* preceded by a vowel, retain the *y* in both ("weak") participles (*buoy, buoying, buoyed,* and so also *lay, pay, spray.*

Dissyllabic and polysyllabic verbs ending in two consonants add the suffixes regularly (*adapt, adapting; expend, expended*); those ending (1) in one consonant (2) preceded by one vowel and (3) accented on a syllable *other than the last,* add the suffixes regularly (*shov'-el, shov'-el-ing; fo'-cus, fo'cus-ed*); those ending (1) in one consonant, (2) preceded by one vowel, and (3) accented on the final syllable, double the final consonant before *-ing* or *-ed* (*ac-quit', acquit'-t-ing; e-quip', equip'-p-ed*); those ending in one consonant preceded by two vowels, are regular (*bias, biased*);

those ending in *c,* add *k* to preserve the hard sound (*picnic-k-ing, shellac-k-ed*); those ending in one vowel, other than *e,* or in two vowels, including double *e,* add the endings regularly, save that the *e* of *-ed* is dropped after *-ee* (*huzza-ing; dye-ing, ey(e)-ing,*—but, *accru-ing, tattoo-ed; agree-ing, agree-d*); those ending in *e,* drop the *e* as a rule before participial endings (*become, becom-ing; arrange, arrang-ing, arrang-ed*); those ending in *y* preceded by a vowel, add the endings regularly (*assay, assay-ing; employ, employ-ed*); and those ending in *ie* drop *e* and change *i* to *y* before *ing* (*lie, lying*).

-city, -sity.

Many nouns in *-ity* (*Latin, civ-itatem; French, cité*; English, *city;* or, *dens-itatem, densite', dens-ity*) are difficult to spell for the reason that *c* is softened by the palatal vowel *i* of *-ity* into the sound of *s.* Nouns having corresponding adjectives in *-se,* or in *-ous,* are spelled in *-sity* (*dense, density; curious, curiosity*). Most others are spelled in *-city;* certainly so if the noun has a corresponding adjective in *-ic* (*basic, basicity*); or if it has a Latin adjectival cognate in *-x, -cis* (*duplex, duplicis; duplicity*); or a Latin verbal cognate in *-co* (*complico, complicity*). Those who do not know Latin, should consider the spelling of related English words, especially adjectives in *-ious* and verbs in *-ate,* and spell accordingly (*capac-ious, capacity; duplic-ate, duplicity; sagac-ious, sagacity; lubric-ate, lubricity*). A few words, mostly in *-city* from Latin adjectives do not follow these rules. Consider the spelling of the abstract nouns from the following:

basic, eccentric, elastic, electric, periodic, plastic, public, septic, specific, spheric.

atrocious (atrox), capacious (capax), complex, duplex, felicitous (felix), mendacious (mendax), perspicacious (perspicax), pertinacious (pertinax), simplex, tenacious (tenax), velox, veracious (verax), complico, duplico, lubrico, multiplico, opacus, paucus, reciprocus.

* * * * * *

adverse, dense, diverse, false, intense, perverse, universe, verbose, viscose, acetous, aqueous, curious, generous, luminous, parous, sinuous, specious, extensive, propensus, tortuosus, verbosus.

-ment

Note the change of *i* to *y* in *accompaniment,* and the dropping of the *e* in *abridgment, acknowledgment, judgment,* and *lodgment',* (Cf. *arrangement, disparagement, encouragement,* and *enlargement*). Note also the various spellings of *fulfilment* and *instalment.*

-ant, -ent

The spelling of English words in *-ant, -ance, -ent, -ence, -ancy* and *-ency* is apparently in hopeless confusion. This is due in part to a leveling of Latin conjugational endings in *-ans, -antis, -antia,* and *-ens, -entis, -entia,* to the uniform Old French suffixes *-ant* and *-ance,*—the *c* of the latter being a misreading of manuscript *t;* and in part to a forming of all sorts of English words with this old suffix (*guid-ance, further-ance*). Most of these words are nouns and adjectives; a few are verbs (to *countenance*); and along with them a few others occur in *-end* (Latin *-endus; reverend*) and *-ents* (*precedents; presents.* "Presents endear absents." —Lamb). The *y* of the *-ncy* endings is a survival of the *i* of a Latin suffix *-cia* denoting condition or quality.

As in earlier sections, attention must be given to the omission of the final *-e* of a word taking these suffixes (*confide, confidant; diverge, divergent*); and of the doubling of the final consonant as before *-ing* and *ed* (*rid, riddance, expel, expellant; concur, concurrent;* cf. *claimant, existent, different, coherent;* cf. *deter', deter'rent, interfere, interferent.* Note the change of a stem letter in *variance, pendency, continent, conversance, prevalence, maintenance, entrance, encumbrance, hindrance.*

Just as the Latin *-entia* gives English *-ence,* so the Latin past participle *-ensus* gives the English *-ense* found in such words as

> condense (*condensus*), defense (*defensus*), dense, dispense, expanse (*expanus*), expense, immense, incense, (in)tense, (non)sense, offense, prepense, pretense[1], recompense, response, suspense, sense. *License* (*licentia*) is exceptional.

-eous, -ious.

A good many suffixes in English derived variously from the Latin *-osus,* meaning "full of," cause difficulty because of such confusions as are possible between *-eous* and *-ious,* *-icious* and *itious,* *-aceous* and *-acious,* and the like. The sense of the original suffix is preserved in such words as *dangerous, mountainous* and *vigorous.*

-eous. bounteous, courteous, erroneous, extraneous, gorgeous, heterogeneous, homogeneous, righteous, aqueous, calcareous, cinerous, gaseous, igneous, ligneous, plumbeous, siliceius.
-ious. anxious, arsenious(!), cautious, conscientious, conscious, copious, deleterious, dubious, gracious, ingenious, injurious, impervious, laborious, meritorious, noxious, obvious, officious, precarious, pretentious, spacious.
-icious. avaricious, judicious, malicious, meretricious, suspicious.
itious. adventitious, ambitious, expeditious, factitious, propitious.
-aceous. aluminaceous, arenaceous, argillaceous, carbonaceous, crustaceous, micaceous, porcelanaceous.
-acious. capacious, efficacious, fallacious, mendacious, rapacious, sagacious, tenacious, veracious.
-ageous. advantageous, courageous, outrageous. Cf. contagious.

-er, -or.

A large group of words in English ending in one or another of the suffixes *-ar, -er, -or,* present a certain amount of difficulty because of a leveling of their pronunciation to the sound *ẽ* (*fẽrn*) or to the almost indistinguishable sound *û* (*ûrn*). No group of words in the language is more interesting than are these in point of derivation, but unfortunately the derivation offers little assistance in the spelling. These words have belonged to the people rather than to scholars, and in long popular service have met with many a strange mischance. Examples we give with certain of their collateral relatives.

-ar. beggar, liar, scholar, bursar, burglar, cedar, calendar, dollar, ashlar, pillar, poplar, cellar.
-er. miller, coroner, calender, loafer, skipper, cooper, cylinder, plaster, bowlder, ledger, caliber, ladder.
-or. tailor, chancellor, assessor, governor, janitor, visor, parlor, corridor, anchor, equator, harbor.
-oir. warrior, reservoir.
-eur, -ure. chauffeur, connoisseur, camoufleur, armature.
-ere. tuyere, belvedere.

-ier. soldier, financier, chandelier, chiffonier, glacier.
-eer. engineer, mountaineer, pioneer, overseer, veneer.
-yer. lawyer, sawyer.
-ster. tapster, dabster, teamster, huckster, roadster.
-re. theatre.
-ary. actuary, auxiliary, mercenary, secretary, boundary, dictionary.
-ry. vestry, gantry, quarry.
-ery. buttery, chandlery, distillery, cemetery, colliery.
-ory. dormitory, repository; auditorium, moratorium.
-aire. millionaire, legionnaire, questionnaire.

-ce, -se.

Strange to say little difficulty is encountered in spelling a large group of words with variant letters but identical pronunciations; such, for example, as the following:

brace, furnace, menace, surface, terrace, base, case, chase, erase, purchase;
scarce;
sparse;
amerce, coerce, commerce,
adverse, diverse, disperse, inverse, traverse;
enforce, perforce, resource, source,
coarse, discourse, endorse, recourse;
conduce, deduce, induce, produce, reduce, diffuse, excuse, obtuse, profuse;
accessible,
assessable;
cede, ceiling, cell, cession, cite, council, intercept,
seed, sealing, sell, session, site, counsel, transept;
oscillate, pretence, supersede, vice, vicinity,
ossify, pretension, succeed, vise, viscidity.

-y.

Few sets of words present more difficulty than those that first add *-y* (Anglo-Saxon *-ig,* "characterized by") and then append other suffixes, such as *-ly, -er, -ish,* or *-ness.*

Words ending in two vowels and one consonant (*loam, wool*) change the *y* to *i;* thus, *loam, loam-y, loam-i-ly, loam-i-est, loam-i-ness.* Final *l* is doubled before *y;* but with the change of *y* to *i,* the second *l* drops away, thus, *wool, wool-ly, wool-i-er, wool-i-ness.* (But see Webster's *woolliness, gravel-li-ness.*)

Words ending in one vowel and one consonant double

the consonant according to the rules for the participial endings *-ing* and *-ed* (page 137).

> **fog-g-y, fog-gi-ly, fog-gi-er, fog-gi-ness**
> **japan, japan-ni-er**
> **gravel, gravel-l-y, gravel-i-er, gravel-ish, gravel-i-ness.**

Note in certain words in *-er* the loss of *e*,

> **winter, wintr-y, wintr-i-ly, wintr-i-ness.**

Words ending in two consonants are quite regular, changing the *y* to *i*. Note that *x* (*ks*) is treated as a double letter.

> **chalk, chalky, chalkily, chalkiest, chalkiness**
> **wax, waxy waxiest, waxiness**
> **zinc, zincky zinckiest, zinckiness**

Words ending in two consonants and *e* (*sponge*) drop the *e* and add the suffixes regularly (*spongy, spongier*, etc.).

Words ending in one consonant plus the vowel *e* drop the *e* before suffixes. When the consonant is *l*, this *l* is doubled after the dropping of the *e* (*grease, greasy, greasily; whole, wholly*) Note especially,

> **fire, fiery, fierily, fierier, fieriness**
> **Cf. wire, wiry, wirier, wiriness**
> **sky, skyey**

Words ending in a consonant and two vowels are well considered individually.

> **clay, clay-ey, clay-ly, clay-ey-ly, clay-ey-est, clay-ey-ness**
> **glue, glu-ey, glu-ey-est, glu-ey-ness**
> **due, du-ly**
> **dull, dull-y**
> **willow, willow-y willow-i-est**
> **arabesque arabesque-ly**
> **japanesque, japanesquery, japanesquely**

Plurals

Most English nouns form their plural by adding *s* to the singular; thus,

> **cupola-s, torque-s, trustee-s, aqueduct-s, caisson-s, column-s, derrick-s, maneuver-s**

Nouns in *-f* and *-fe* sometimes form the plural regularly (*hoof-s, fife-s*); sometimes by changing the *-f* or *-fe* to *v*

and adding *es* (*half, hal-v-es; knife, kni-v-es*); and still again, in both these ways (*wharf,—wharf-s,* in England, and *whar-v-es* in the United States).

Nouns in *-o* show divided usage; *o* preceded by a vowel regularly adding *s;* as also does *o* preceded by a consonant save in a numerous group of rather old, familiar words that add *es*. In the case of a few words both *-os* and *-oes* plurals are commonly found.

> *-os.* bamboo-s, cameo-s, (port)folio-s, radio-s, ratio-s, studio-s, auto-s, dynamo-s, magneto-s, proviso-s, silo-s.
>
> *-oes.* cargo-es, dado-es, echo-es, negro-es, potato-es, tomato-es, embargo-es, hero-es, manifesto-es, motto-es, tornado-es, torpedo-es, veto-es, volcano-es.
>
> *-os* and *-oes.* dominos[1], or dominoes; halos[1], or haloes; zeros[1], or zeroes; archipelagoes[1], or -os; calicoes[1], or -os; frescoes[1], or -os; grottoes[1], or -os; porticoes[1], or os. Cf. alkalies[1], or alkalis.

Nouns ending in *-s, -ss, -x, -z, -ch,* and *-sh* form their plurals by adding *-es* to the singular; thus, *gas-es, pass-es, ax-es, arch-es, adz-es, ash-es.*

Nouns ending in *-y* preceded by a vowel form the plural by adding *s;* and those in *-y* preceded by a consonant, by changing the *y* to *i* and adding *-es,* thus, *alley-s; ally, all-i-es.*

Signs, etc.

Signs, symbols, figures, letters, and isolated words regularly form the plural by adding an apostrophe and *s* (*'s*); thus, %'s. Y's (wyes), t's, 10's, the's.

A number of nouns have two plurals with differentiation of meaning:

> cannon, cloth, die, domino, dozen, fish, index, score, shot, staff, stock, stone.

A few words, like *news,* although plural in form are grammatically singular; and a few others, like *anyone* and *everyone,* although logically plural, are grammatically singular. Contrariwise, names of sciences ending in *-ics,* although plural in form are grammatically singular; e.g.,

> acoustics, conics, dynamics, economics, hydraulics, hydrostatics, kinetics, kinematics, mathematics, mechanics, optics, physics, statics, statistics.

Where, however, the reference is not to the body of a science, but to a body of exercises (*athletics, gymnastics, tactics*), these terms are properly regarded as plural. In general, nouns with plural forms are treated as plural, such for example, as,

assets, compasses, eaves, forceps, headquarters, odds, tongs, wages.

Collective nouns, such as *council, jury, committee,* are treated as either singular or plural, accordingly as they are regarded as being made up of individuals, or as constituting, and acting as, a single body.

Compound nouns of measure, like *bucketful,* or *spoonful,* form the plural *of that measure,* by adding *s* to the singular (*bucketfuls, wagonloads, spoonfuls*). Note the difference in meaning between these and *two shovels full* or *two baskets full.* These cases follow the general rule that the noun rather than the modifier takes the sign of the plural. Cf. *courts martial, centers of gravity, figures of eight.* But see *attorney-generals!*

A few nouns have singular and plural alike (*apparatus, debris, gross, series, species, superficies*).

Some few nouns derived from Latin and Greek retain their original plurals, giving us,

algae, addenda, data, errata, calculi, analyses, antitheses, crises, hypotheses, theses, parentheses, criteria, phenomena, genera, matrices, vertices, and the like.

Others of these derivatives have taken second plurals after the English manner, sometimes with a difference of meaning; such are,

formula, abacus, apparatus, focus, genius, radius, curriculum, frustum, fulcrum, medium, memorandum, spectrum, appendix, apex, helix, index, radix, vortex, phalanx; datums (for elevations).

All in all, shall we conclude, the spelling of English is no child's play; usually plenty remains to be learned after one has left the days of childhood.

Exercise.—1. Determine which of the following spellings Webster prefers:

abridgment, abridgement; acknowledgement, acknowledgment; aline, align; ax, axe; briquette, briquet; canon, canyon; coulter, colter;

comptroller, controller; creasote, creosote; dyke, dike; dispatch, despatch; disc, disk; drily, dryly; fagot, faggot; filagree, filigree; foundry, foundery; gage, gauge; glycerine, glycerin; gramme, gram; endorse, indorse; instalment, installment; licence, license; pipette, pipet; plough, plow; prospector, prospecter; reconnaissance, reconnoissance, rosin, resin; salable, saleable; selvege, selvage; silicious, siliceous; sheeve, sheave; skilful, skillful; smoulder, smolder; staunch, stanch; sulfate, sulphate; swedge, swage; templet, template; phial, vial; woollen, woolen.

2. Add *-able* or *-ible* to the following:

combust-, credit-, compet-, convert-, indomit-, percept-, prevent-, indubit-, ignite-, irrit-, tract-, resist-, regret-, suscept-, flex-, tax-.

3. Add *-ing* and *-ed* to the following:

check, crush, hoe, lock, mix, span, file, owe, hinge, haul, trace, manage, knead, fringe, key, eye, seize, blue, swim, notice, tie, dye, collect, bevel, fulfil, occur, travel, squeegee, dye, shoe, traffic, rivet, parallel, bury, clarify, quarry, enamel.

4. Add *y,* and then, wherever possible, add *-ly, -er,* and *-ness*:

oil, slop, mold, dough, ridge, noise, dew, stone, sedge, ink, dirt, order, soap, roil, grit, worth, sponge, ease, sinew, showy.

5. Form the plurals of the following:

ridge, sluice, shelf, quartz, quay, velocity, cumulus, spectrum, series, guarantee, lens, life, notch, survey, quarry, bacillus, addendum, parenthesis, matrix, analysis, nucleus, pailful, economy, torch, reef, buzz, attorney, guy, story, minutia, terminus, datum, nucleus, synopsis, minimum, appendix, nebula.

CHAPTER XI

REPORT WRITING

- The nature of reports.
  - Function.
  - Varieties.
  - Significance.
- Characteristics of reports.
  - Makeup.
    - Letter of transmittal.
    - Message.
    - Appendix.
  - Qualities.
    - In the document.
      - Clearness.
      - Correctness.
      - Comprehensiveness.
    - In the writer.
      - Definiteness.
      - Discrimination.
      - Dependability.
- The threefold personal criteria.
  - Perception.
  - Judgment.
  - Integrity.

Modern enterprise of every sort tends toward an elaborate form of organization involving the cooperation of many mutually related parts. It involves the division of labor and the delegation of authority, frequently through many stages reaching down from the top through the body of the organization. To preserve the necessary contact between these parts, which often are widely separated in physical position, presents a problem of considerable proportions. Actual visitation and personal interviews are uneconomical of time and even more unsatisfactory as regards their permanent

and unmistakable presentation of facts. The casual letter because of the convention which limits it to the severest standard of unity—to the setting forth of but a single topic, is unfitted for the larger requirements of business. These considerations have led to the development of a new type of document, called the report letter, or simply the report. This form treats comprehensively any certain range of facts, minor or major; in large organizations it is apt to pass between inferior officers and their superiors at every level, and during the course of a year affords in various perspectives a view of every changing condition of the enterprise. Its very preparation insures the bringing of conditions most sharply before the consciousness both of the writer and the reader; and once it has been produced it stands as a permanent and conveniently accessible record of some significant phase or feature of development. Upon it, finally, depends the action taken by those in control, and communicated from them down through the various orders of subordinates.

The importance of the part played by the report in modern life is sufficient argument for its effectual mastery by anyone who hopes to make a place for himself in this mighty fabric of affairs. Not only must such an one see conditions; he must analyze them. He must be able to make expert depositions and advisements regarding them; and he must have the power to communicate the essential facts of any situation in a manner that is in accord with the accepted standards of his profession. Ability to do this is a main criterion in determining advancement,—in determining promotion in rank and salary.

Originally "reports" were things "brought" (*porto,* "to carry") "back" (*re,* "again"); and despite the changes in modern conditions, this is essentially what they remain. The place of their inception or emanation, their "base" so to speak, is not the writer, but the superior to whom the writer addresses himself. They are in each case expected, awaited, as a regular part of some commission or assignment. They are produced at the command, or at the request, of some authority desiring trustworthy and confidential information, the result of immediate knowledge regarding certain conditions; they often include, moreover, as a proper part of

their presentation, appraisements, estimates, and recommendations of procedure based upon such first-hand research or investigation.

These documents are of various sorts. Some are periodic, weekly, monthly, quarterly, annual,—part of the regularly assigned routine of some executive position. Such are often reduced in their general outlines to composite forms, suggestive rather of our original outlines than of finished compositions; yet affording, as did these, abundant opportunity for manifestations of earnestness and ability, or of their opposites. Such reports are but incidental to the regular administration of every highly organized enterprise whether economic, political, social, or educational. But we have another sort of report of a more special and occasional nature. This provides no forms and exacts none save those dictated by common sense and a due regard for usages that have come to be established as the result of long experience. Here, as the responsibility is greater, the opportunity for doing distinguished work increases proportionally. The commission to prepare such a report marks the executor as a person looked upon as competent and responsible and worthy of implicit trust.

The vocabulary of reports reveals the extent to which their writers have risen to the higher and rarer atmosphere of affairs, the extent to which they have attained to immediate contact with executive responsibility. The abstractness of the language is suggestive rather of Rome than of some Gothic quarry or Phrygian forge. They deal not with "wood and stone" and but with "materials"; not with hewing and hoisting but with prevalent conditions and situations, with problems to be solved and programs to be put into operation, with facilities for procedure and with costs, valuations, assets, and liabilities. The writer of reports does not talk hearsay and gossip; rather he details accurately the results of studious application to, and thorough investigation of, the matter at hand, he enumerates, itemizes, analyzes, and interprets the data he has collected on his survey. To these he adds calculations, estimates, conclusions, bearing on the validity or advisability of this or that project or proposal. As the result of what he has observed or ascertained

by his inquiry, and after mature and judicious consideration, he gives his opinion, his deduction—his advice, recommendation, suggestion, counsel—bearing on a solution. All this he "transmits" or "submits" or in his capacity of a confidential agent "has the honor to present" to those he serves, placing it before them as a conservative, reasonable, and correct digest of circumstances then existing and likely to develop, and as a document wholly qualified to serve as a material factor in determining the immediate action to be taken and the final policy to be pursued. Such is the language and such is the attitude of achievement.

Characteristics of Reports

Our purpose in this section is to show something of the makeup of reports and to give something further regarding the qualities especially desired in their composition.

An engineering report may conveniently be regarded as made up of three main divisions roughly corresponding to our familiar introduction, body, and conclusion. The first of these, tantamount to an introduction, may take the form of a letter, called the "letter of transmittal," addressed to the individual or to the body of individuals by whose order the work covered by the report was carried out. Its first business, of course, will be definition. To this end it may well begin with some specific reference to their commission to the reporting party, and may properly contain a memorandum of the very terms of the assignment. This will serve as introduction to a comprehensive statement of the history of the case subsequent to the authorizing of the work. The writer's interpretation of the field of his activities as applied to the actual situation, possibly certain limitations, or exclusions, deemed advisable for one reason or another, may also be touched upon. When the scope and coverage of the investigations have been thus outlined, some suggestion may properly be made to their more salient aspects, and a brief résumé entered into of the results arrived at and of the conclusions reached, this abstract being but the anticipation in epitome of an exposition to be entered upon more fully in the body of the report. This introductory

section, like those of our other papers, may appropriately close with a statement of division,—with a precapitulation of the successive headings under which the body of the report is to be presented. Quite possibly the supplementing of each of these heads by a brief word of explanation may appear advisable.

Next follows the body or text of the report proper. Its subject, of course, will be the exposition of the work assigned. It will begin with a formal title page, like any book or pamphlet, stating in lines properly grouped and spaced that this is a "Report on . . ." whatever the subject matter may be, "Submitted to . . ." the authorizing body, here fully and accurately named, "by . . ." whatever the name of the reporting party may be, all this to be followed at the bottom of the page by a mention of the date when the document was submitted. Next follows a table of contents accompanied by page references.

The first part of the message will normally concern itself with an explicit statement of the work accomplished —of the thing attempted, the methods followed, and the results obtained. Everything should be presented in relation to everything else; all data should be set forth in systematic, organic form; and in the striving for this effect, not a little of the preliminary tabulation of headings—both centered and marginal—may be allowed to remain. Further than this we can, in this brief treatment, scarcely go. The order of presentation will in every case be determined by circumstances; but *order* in the assembling of sections and details will inevitably and invariably be found.

The "conclusion," if such we may call it, is the latter end of the report, wherein the findings, already presented, are further discussed and digested, and from them certain definite determinations arrived at. The evidence is in; what can be made of it? What are its aspects; what is the complexion of the case; through what phases may it be expected to run its course; what technical or economic matters appear to be determining factors in its deliberation? Here may come notes regarding existing conditions, or probable developments of special moment; and possibly some drawing of parallels to other situations that may throw light on this.

And then, at the end, recommendations may be suggested, or presented urgently, bearing either upon the things to be done, or on the guiding principles to be observed in the prosecution of the enterprise; some piece of formal advice —that of a professional man speaking in his peculiar consultative capacity—setting forth the factors involved and the line of operations that would seem to promise the most successful outcome.

Accompanying the body of the report, and forming with it and the letter of transmittal a sort of tripartite document suggestive of contract, specifications, and plans, come such supplementary and more severely technical devices of representation as may be deemed advisable. Such are photographs, drawings, graphs, diagrams, data sheets, or formal tabulations, all properly identified by numbers and titles; and possibly, also, if the nature of the report would make it useful, an index. These serve as a check upon whatever has gone before; provide other professional men a basis for the exercise of independent judgment; and in doing this constitute no unimportant part of the document as a whole. Reports should be typed and the writer should retain a carbon copy.

Thus the report progresses from the general, through details to the general again. It has its beginning, its logical course of unfolding, and its end. Within this range, it may play many different parts; it may be formal or informal, tentative and preliminary, or supplementary, or final. In its length it may be comparatively simple, or abbreviated on the one hand, or on the other, thorough-going and voluminous and complete.

Qualities

We come now to a consideration of the desiderata of reports. In the first place let us consider this matter from the point of view of the paper itself, and then from that of the man who writes it. Of the report itself we desire that it be comprehensive, clear, easy to follow even by the layman,—so presented as to facilitate the mastery of its every detail by any interested party; so arranged as to ren-

der immediately available every last item of information that it may contain. This is the first essential on the side of form; on the side of fact, the first requirement is that in so far as it goes it be correct in all its representations, and that in completeness and comprehensiveness it cover the full circle of the significant. The writer of reports should remember that fortunes and reputations often hang on such representation as he may make. Of high secondary importance we should rank coherence and conciseness. Everything in the report should be organic, systematic, well-articulated. This means that further revision in the direction of an arrangement more natural, common-sense, or business-like, should be practically impossible. Finally, the report itself should be as meaty as an egg; suggestive of the telegram in its brevity; written throughout with an eye on Caesar's celebrated model, "*Veni, vidi, vici.*" Concentrated, it should be—condensed, compacted.

Qualities of the Writer

And of the man—what of him do we desire? Ruskin says somewhere that the greatest thing in the world is to see something, and to tell another what one saw in a plain way. In the first place, this report writer of ours must prove his ability to see something, and that more than the casual and obvious features of a situation. He must look with a discriminating, diagnostic eye—the eye not of a layman, not merely of a laborer, but of a professional, of an expert in his field—to some extent, of an authority. He must examine with an eye trained by experience to focus, not on the generic features, but on the *differentiae*. More than this, he must see with the mind, and not merely with his eye; and so seeing, mark the cause, the reason, behind every appearance. And once again, he must see with his imagination; and in this forward-carrying vision translate facts potential in phenomena into their ultimate fruition. His eye should fix upon the cardinal and critical; and cutting out achromatic fashion all gaud of color, present only the significant outlines in their white and black.

Such in general are some of the more obvious criteria whereby we judge professional reports. We assume that the writer will supplement his memory of conditions by notes taken on the spot,—the notebook in inspection work being only less essential than the field book in surveying. All we have said, moreover, implies in him an ability to do something more with the facts there noted than to list them down the page. In report writing we desire clearness and accuracy of perception. We desire, furthermore, outstanding competency of judgment, that the writer throughout his presentation be convincing, cogent, and conclusive. We desire, finally, that he show himself sincere, earnest, and conscientious in his desire to serve. Before he expects us to believe in him he should obviously believe in himself. Confidence we bestow where confidence is manifested. Professional ability must be supplemented by professional integrity. We want efficiency, but efficiency we cannot accept as the only criterion of high success.

From the writing of minor reports the path of opportunity leads directly to the preparation of those of greatest consequence; and in few ways can a man better recommend himself as worthy of advancement than by the character of the reports he submits of whatever affairs are given him in charge.

Prepare a report for the University authorities, the City Council, or Board of Trade, or for some out-of-town engineering, contracting, or utility company, based on some such assignment as the following:

The condition of some two or three blocks
- of unimproved city street
- of old pavement in need of repair

The condition of some
- highway bridge and its approaches
- railway crossing and its approaches

Some proposed
- traffic or parking regulations
- zoning ordinance as applicable to a restricted area
- scenic driveway
- drainage project
- recreation grounds or athletic stadium
- change in a street car or interurban routing

CHAPTER XII

PRONUNCIATION

No attempt can be made in this volume at any thoroughgoing treatment of this subject. Our endeavor must be limited to a pointing out of the main sources of difficulty, and to the calling to attention of two or three dozen words upon which speakers frequently stumble. Most of the difficulty in pronunciation arises from one or the other of two causes: a failure to place the accent on the right syllable, or a failure to give the correct quality to some vowel. Usage, as reflected in the dictionaries, shows striking divergencies in many cases. Often where the authorities agree on the main features of a word they disagree regarding some minor syllable—its stress or its tonal quality. No attempt is made in our list to mark these lesser differences; an attempt is made, however, to set forth main features of pronunciation as these are applied by reputable authorities to the words in the list.

Every student should familiarize himself with the diacritical marks by which the sounds of words are represented. Several systems of these exist; and they are supplemented by phonetic alphabets which attempt by altering the literal symbols to represent sounds still more exactly. Perhaps the most familiar of these systems is that used by *Webster*, in which the vowels variously marked are generally represented by the words that accompany them below:

ā—pale, ate; ā̍—sen′ate, cour′age; ă—at, tap; â—air, share; ȧ—last, pass; ä—art, palm; ē—eel, feet; ē̍—evade′, create′; ĕ—ebb, error; ẽ—fern, ermine; ī—item, rite; ĭ—bit, bid; ō—go, note; ō̍—oa′sis, obey′; ŏ—fog, sod; ô—lord, order; oi—soil, toil; o͞o—ooze, moon; o͝o—book, wood; ou—out, shout; ū—cube, usage; ū̍—uten′sil, usurp′; ŭ—cup, utter; û—fur, urge.

The following pronunciations have behind them the authority of at least two of the major dictionaries. In many

cases, however, second and even third and fourth choices are given; and in most cases markings appear on syllables that are here left unmarked. To get at the whole story of the pronunciation of any word, one should look it up in *Century* and *Standard*, in the *Oxford* dictionary and in *Webster*. At the end of Webster's "A Guide to Pronunciation," appears an extensive list of variants that is most helpful.

acclī'mate		conduit	kŏn'dĭt
acetous	ȧs'etus	consignee	kon sī nē'
acoustics	a kōōs'tiks	consignor	kon sīn'er
address'		con'tents	
adept'		creek	krēk
adobe	a dō'bĕ	crystalline	kris'tăl ĭn
advertisement	ad vûr'tĭz ment	datum	dā' tum
aerate	ā'er āt	debris	dā brē'
alkali	ăl'ká lī Cf. Web.	defalcate	dê făl'kāt
alkaline	ăl'ka līn	defect	de fect'
apparatus	ap a rā'tus	dem'onstrate	
aqueus	ā'kwe us	depot	dē'pō
artesian	är tē'zhăn	desideratum	dē sid er ā'tum
asbestos	as bes'tŏs	designate	dĕs'ig nat
asphalt	as'fălt	detail'	
automo'bile		detonate	dĕt'ō nāt
auxiliary	og zil'ya ri	detour	dê tōōr'
avoirdupois	av er du poiz'	dilate	dĭ lāt'
basalt	ba sôlt'	dilute	dĭ lūt'
bayou	bī'ōō	direct	dĭ rĕkt'
benzine	bĕn'zīn	discard'	
bitumen	bĭ tū'men	dis'count	
bomb	bŏm	dis'putable	
boulevard	bōō'le vȧrd	diverse	dĭ vûrs'
bromide	brō'mĭd	divert	dĭ vûrt'
bromine	brō'mĭn	economic	ē kô nŏm'ik
buoy	boi	electricity	ē lek tris'i ti
caisson	kā'son	employee'	
calcimine	kal'si min	engine	en'jĭn
calcine	kăl sīn'	en route	än rōōt'
caloric	kal ŏr'ik	entresol	en'ter sol
cañon	kăn'yun	erratum	ĕ rā'tum
cantilever	kan'ti lē ver	esplanade	es pla nād'
can'tonment		ex'igency	
cement	sê ment'	explic'it	
chassis	(Look up.)	facade	fa säd'
chloride	klō'rĭd	Fahrenheit	fä'ren hīt
clapboard	klap'bōrd	February	feb'rōō â ri
com'parable		finance	fĭ năns'
com'pensate		financier	fĭn ăn sēr'
con'centrate		franchise	fran'chĭz Cf. Web.

gape	gȧp
garage	ga razh′
gaseity	gas ē′i ti
gaseous	găs′e us
gasoline	gas′o lēn
gelatin	jel′ȧ tĭn
gelatinous	je lăt′ĭ nus
genuine	jen′ū ĭn
glacier	glā′sher
glazier	glā′zher
glycol	glī′kōl
glycerol	glỹc′ēr ōl
grease	grēs
hangar	(Look up.)
hygiene	hī′jĭ ēn
hypogene	hĭp′o gēn
hypotenuse	hī pŏt′e nūs
illus′trate	
improvise′	
incom′parable	
indis′putable	
indis′soluble	
in fer′able	
inquiry	in kwir′ĭ
interstice	(Look up.)
inundate	(Look up.)
iodide	(Look up.)
irrep′arable	
isolate	ĭs′o lāte Cf. Web.
kil′ometer	
laboratory	lăb′o ra to ri
launch	lanch
lenience	lē′nĭ ĕns
levee	lĕv ē′ Cf. Web.
lever	lĕv′ er Cf. Web.
lien	lē′ĕn
loess	lûs Cf. Web.
magnesium	(Look up.)
magneto	mag nē′to
matrices	măt′ri sēz
matrix	mā′trix
mercantile	mur′kan tĭl
mezzanine	mĕz′a nĭn
mineralogy	min er ăl′o ji
mobile	mō′bĭl
municipal	mu nis′ipăl
naphtha	năf′tha
naphthol	năf′thol
nitrogenous	nī trŏj′e nus
ob′ligatory	
oblique	ob lēk′
often	of′n
overseer	o ver sē′er
oxide	oks′īd Cf. Web.
paraffin	par′a fĭn
patronage	păt′run âj
per′emptory	
personnel′	
petrol	(Look up.)
phenol	fē′nōl
pilaster	pĭ lăs′ter
porcelain	pôrs′lân Cf. Web.
precedence	pre sēd′ens
prestige	pres tēzh′
pretense	pre tĕns′
prima facie	prī ma fā′chi ē
process	prŏs′ es
promenade	prom e näd′
protein	prō′tē ĭn
pyramidal	pĭ ram′i dal
ratio	rā′shĭ o
recess	rē sĕs′
recourse	rē kōrs′
ref′erable	
research	rē sûrch′
reservoir	rez′er vwor
resource′	
ricochet	rĭk ō shā′
roily	roil′i
root, route	rōōt, rōōt
seine	sān
serpentine	ser′pen tīn
simultaneous	sī mul tā′ne us
soot	sŏŏt
status	stā′tus
stratum	strā′tum
superficies	sū per fĭsh′i ēz
tepid	tĕp′id
toward(s)	(Look up.)
turbine	tûr′bĭn
vaseline	văs′e lĭn
vitriol	vĭt′rĭ ŭl

Exercise.—1. Look up the nominal and verbal, or nominal and adjectival, or verbal and adjectival, pronunciations of the following words:

alternate, compress, concrete, conduct, contrast, contract, diffuse, envelope, expert, export, impress, incline, increase, minute, permit,

precedent, premise, present, produce, protest, record, retail, sacrifice, transfer, detail, discount, discard, exploit, offset, perfect, prefix, recess, recount, refund, relay, survey, traverse,

2. Look up the pronunciation of the following:

annex, contour, convex, patent, profile, bowsprit, Röntgen, corollary, distillate, egotism, envelope, illustrate, maritime.

CHAPTER XIII

THE SUPPLY-OF-MATERIALS TALK[1]

General concern of the main divisions.
- Of the introduction.
- Of the body.
- Of the conclusion.

More particular concern of these divisions.
- Of the introduction—The subject of discussion.
  - Origin of the discussion.
  - Definition of terms.
  - Historical notes.
  - Statement of division.
- Of the body—The supply of material.
  - Natural features.
    - Its location.
      - Geographical.
      - Geological.
    - Its abundance.
      - Present.
      - Prospective.
  - Economic features.
    - Production.
      - Difficulty.
      - Cost.
    - Control.
      - Financial.
      - Governmental.
- Of the conclusion—Conditions affecting the supply.
  - Accessories to the presentation.
    - Industrial considerations.
    - Social considerations.

Few subjects offer better opportunities for systematic development than does this. The talk may be expected to

[1] For suggestions regarding the conducting of such oral recitations, see pp. viii–ix, 200–201.

show a well-defined introduction, body, and conclusion. The first of these divisions may well include some reference to the occasion for discussing the topic, a defining of the material, something perhaps of its history, and in the last place—marking this fact, indeed—some reference to the aim of the presentation. The body will naturally discuss the features of the industry, and set forth the conditions, natural and economic, that govern the supply. The conclusion may quite possibly stress the importance of the material, and forecast the possibility of effecting a balance between demand and supply, pointing out the factors of the problem, and indicating as far as possible the key to a solution.

The Particular Concern of the Main Divisions

In the introduction the reeason for discussing the material may be given as a realization of the meagerness or untrustworthiness, or irreconciliability of information current regarding it; or a feeling of the importance of creating in some quarter a particular interest; or concern over a present or prospective shortage; or, it may be, some special knowledge regarding the material, gained either from a comprehensive study of the entire field, or from some intensive investigation of a more limited area. So far as the material is not fully known, a note regarding its nature, its origin, or the forms and conditions under which it appears; possibly a classification of these forms, and a general appraisal of their relative value may be in order. Its history, too—its use in early times, either universally or under restricted conditions; the successive phases and aspects of its modern use, a note on any industrial developments that have affected either the demand or the valuation; or on any imminent change that may effect an inflation or depression of the market—belongs quite possibly in this division. And, at the end, marking the transition to the main discussion, we look for an explicit statement of what this presentation is all about. Is it to describe the situation as it exists as a whole, or to set forth statistical data bearing on one or more of its features? Is it to discuss the subject in a manner purely

expository; or to take it up in an argumentative way, looking to some alteration of the attitude of the auditors?

The Supply of Material

Always, in such a topic as this, the natural and economic features are important both in themselves and in their mutual relationship. The geographical aspect we have, and also the geological; the permanence of the supply and the prospect of avoiding any possible depletion. We want to know, for instance, where the stuff exists, whether at home or abroad; its proportionate distribution, the annual yield, the reserve, its grades and the qualities; the conditions under which it is found, its workability, the rate of expansion or depletion; any steps being taken to eliminate waste, or to govern consumption; and the supplementing of conservation by the development of new resources, either by discovering new fields, or by the replacement of old growths. Economically, we are interested in labor conditions at the points of production; in the facilities for transportation and storage and distribution; and, in a word, in whatever belongs to the organization by which the material is produced, made available for industry, and marketed. This, as likely as not, involves the control of the industry: and possibly, also, of legislation tending to give direction to this control. The ownership may lie in individuals, or in corporations; we may find it in protected interests, or in governmental monopolies. In any case it will affect the sources of supply, the means and methods of production, and the procedure of distribution. Often the story of material involves some notice of statutes and enactments, of legislation and litigation past and pending. Almost inevitably this story will, first and last, be a fascinating one—vital in its realism, varicolored in its romance.

The Conclusion

The conclusion may touch again on changes in the industrial situation, and on the trend of the requirements of life as these affect the demand; or, once more, on the prospects

of providing for these demands by expansion or conservation or, it may be, by substitution.

Accessories to the Presentation

Seldom is a discussion of such a topic as this adequate without maps or pictures, without tables, or graphical representations of proportional distribution or production.

The subject itself may deal with any material mentioned on pages 225, 230, or, with others, such as *mahogany, nitrates,* or *oil shales,* not appearing there. It may treat of a world supply, or of that of any one or more continents, regions, districts, states, or counties. All we ask of the subject matter is that it be interesting and informative.

CHAPTER XIV

THE DEFINITION PAPER

Definition proper.
- Its nature.
  - Attempt at explanation.
    - General.
    - Specific.
  - Process of explanation.
    - The separating out of parts.
    - The phrasing of parts.
- Its conventions.
  - The known parts.
    - Subject.
    - Verb.
  - The desired parts.
    - Genus.
    - Differentia.

Definitional description.
- Attention to the *word.*
  - Examination of its meaning.
    - By etymology.
    - By amplification or iteration.
  - Restriction of its meaning.
    - By comparison.
    - By contrast.
- Attention to the *idea* expressed in the word.
  - Examination of the "thing" itself.
    - By detailing its properties and composition.
    - By enlarging on its process of production.
  - Discrimination of ideas.
    - By the refining of differentiation.
    - By the sharpening of particularization.

How much better we get along without ideas than without words! So long as we do not know the name of a thing,

speech about it is well nigh inhibited. Until the word appropriate to a thing is found, we use various makeshifts—in formal abstract speech referring to it as a "quiddity" or "anomaly," perhaps, and in informal, concrete speech availing ourselves of such vulgarisms as "dofunny" and "hickey" and "thingumajig." Given words, on the other hand, of which we scarcely know one in ten exactly, we are fluent enough. In short, we simply do not know the words we use; and all too often we do not particularly care to know them. In our intellectual laziness we echo Disraeli's, "I hate definitions." Too seldom, at any rate, do we know much about the science of definition; or care at all whether the defining of "hardness," [1] let us say, is hard or not.

In a celebrated vocabulary test looking to the measurement of intelligence,[2] "You burn it outdoors," was considered "acceptable" as a definition of *bonfire;* and *orange* was held to be understood, if defined, "An orange is to eat." Such "definitions"—just as well call them "synonyms"—although they may indicate a wealth of information, reveal at the same time a far lower order of intelligence than would the reply, "I do not know." Far more intelligent answers would have been, "A bonfire is a case of spontaneous combustion," and "The orange is the extent of variation between circumferences infinitely large and infinitely small." In a word, information is tested by the content of definition; intelligence, only by its form.

Knowledge indeed is power, but such knowledge as defines "orange"—"It is yellow and grows on a tree," does not generate enough power to raise a man to those heights where the great engineers wield the power of the world. Every fuzzy mind graduated in engineering is a blot on the escutcheon of the college issuing the diploma. This profession, significantly enough, has earned no nickname analogous to quack or pedagogue, to theologue or shyster. Engineering is efficiency or it is not engineering; and it is efficient beyond other professions mainly for the reason that it is more given than they to definition. Its concepts are precise, quantitative, sharply delimited. It knows, significantly

[1] See the *Engineer.* September 21, 1917, pp. 252–254.

[2] *Literary Digest.* Vol. LVI, No. 7 (February 16, 1918), p. 19.

enough, other terms besides its own; as a matter of course, it makes a study of the terminology of law and of business, of sanitation, and psychology; whereas most other professions are still too medievally minded to study any subject outside their own. "Civil" (cf., "military"), engineering, which in its original sense covers today practically all engineering, was the product, we note, of the same generation that saw our first dictionary. It is in a peculiar sense the most modern of all professions, the most exact and the most exacting of the applied sciences.

Engineering has no place for such as cannot think; and the basis of thought is knowledge,—knowledge exact and orderly in arrangement. The freshman who wrote the following definition of orthographic projection, has beyond a doubt by this time worked round into theology:

> *Orthographic projection.*—"If you are given a picture drawing the side, that you can see to consider the front view is the side, if looking at right angles at all points you can see the most of the object on the one side, is the side that you can see the most of the object from."[3]

Certainly he did not get very far as a student of engineering. I ask an engineering colleague the meaning of any one of such words as appear in the following pages, and I get *some* information, and that, pertinent. Now and then his reply may suggest the motto of the American Engineers in France, "It can't be done; we'll do it,"—he has "forgotten all that," or it lies quite out of his field; but in the end he defines it, after a fashion, and usually after a fashion better than respectable. Power of definition, whether of the eye or of the mind, comes only as the result of practice. Just as we train our eyes to see, so we train our minds to think. The young engineer, therefore, may well exercise himself in the defining—and after strictest rules of lexicography—of such words and phrases as belong to his profession.

[3] Cf.—Orthographic projection is the "true presentation" (or the method of such presentation) upon a plane surface of a figure of three dimensions, —a presentation effected by means of an orderly arrangement of two, three, or more than three drawings, in which are shown the places of perpendicular contact upon several directly opposed surfaces, placed parallel or at right angles to each other, of systems of lines and points brought, or "projected," forward or backward, upward or downward, or sidewise, from all the significant features of the figure to be represented.

Definition we may describe more generally as exposition, that is, explanation, reduced to its lowest terms; as the identification of a thing; as the making clear in words of the conceptual content of a term. The object of definition is to present the exact value, or sentential equivalent, of a word or phrase by expressing it in terms whose meaning is understood. Derivatively, "definition" suggests the "marking down" (*de*) of the limits or "outer edges" (*fines*)—that is, the setting of the boundaries—of a conception. In the words of John Stuart Mill, definition is the "most correct and compact mode of circumscribing . . . the aggregation of particulars comprehended in anything . . . by a general description"; it is "the sum total of all the essential propositions which can be framed with the name for their subject." Hence, in a way, the word "particularization" may serve as a synonym. In this connection, Professor Baldwin observes:

> Practically, luminous division and definition are reached, more often than in any other way, through skilful compilation,—compilation that engages, not only the industry of the compiler but also his intelligence.[4]

The problem, then, is to cover correctly, completely, and concisely, this limited area.

THE CONVENTIONS OF DEFINITION

Every formal definition is made up of certain definite parts. First, of course, we have the Subject, or thing to be defined, and with this the Verb which predicates something regarding this subject. Next, in the process of definition, we come to the naming of a group or class, the Genus, under which the subject of the definition is assumed to be included. Finally, we come to the mention of certain distinguishing marks or essential and peculiar characteristics, the *Differentiae* (singular, *differentia*), which by their presence or absence distinguish the thing defined from all other members of the particular group under which it is classified. Although these parts normally follow the sequence given

[4] Baldwin, Charles Sears, *A College Manual of Rhetoric.* Longmans, Green, and Co., New York, 1909, p. 44.

above, they may come in any order at all. Emerson's sentence, (1) "The conscious utterance of thought (2) by speech and action to any end (3) is (4) art," shows, we note, the arrangement, (1) genus, (2) differentiae, (3) verb, (4) subject.

Having learned what the parts of our formula are, we are interested next in how to fill in this formula. Here a number of problems present themselves. The subject, as a rule, will cause little difficulty, beyond the necessity of distinguishing just what particular one of perhaps its many uses we are attempting to define—whether, for instance, the "machinery" we are defining is that of the common man on the street, or that of Alexander Pope, or that of Matthew Arnold. The verb, fortunately, causes almost no trouble; but not so, the genus. The latter may have a demarking line practically identical with that of the subject—"Resistance," we say, "is opposition." This gives us synonymy. Where, however, the limiting lines of the two words are not the same, as in "A profession is an opportunity," we have merely a non-definitive statement of fact. Obviously, as the circumscribing line of the genus is restricted in extent—and as the true differentiae are multiplied—the definition becomes more and more adequate. Experience advises, however, that, in our selection of the genus, we strike a happy medium, avoiding alike the narrow circumscription which would advance our knowledge too little, and the over-broad, blanket generalization which can convey nothing with exactness. Consider the sequence,

Applied science	Cf. *Pure science*
Engineering	Cf. *Chemistry*
Civil Engineering	Cf. *Mining engineering*, etc.
Sanitary engineering	Cf. *Hydraulic engineering*, etc.
WATER-WORKS ENGINEERING	Cf *Sewerage engineering.*

Here we could use as a genus in defining "water-works engineering" any one of the words immediately above it, our choice being determined in any case by questions of practicability in view of the knowledge of the audience. Selecting a genus conveniently large is not the same as picking one ridiculously loose. In passing, we note that as the genus is

suppressed, and the differentiae or particularizing part elaborated upon, we pass outside the bounds of definition into those of detailed description.

The language of definition should be just as simple and positive and exact as is possible under the circumstances; at once as clear and as concise as is at all consistent with reasonable accuracy. Now this perspicuity does not necessitate that we limit ourselves to homely words. The mere fact of classical derivation does not make a word difficult of comprehension. Consider, for instance, the following definition wherein the words of classical origin are printed in italics:

> The *mechanical engineer's definition* of *efficiency* is the *ratio* of *result obtained* to *effort expended in obtaining* that *result.*[5]

A positive gain in conciseness is often sufficient excuse for abstruse language. How many paragraphs of Saxon words would be required for what Herbert Spencer has packed into one sentence:

> Evolution is an integration of matter and concomitant dissipation of motion through continuous differentiations and integrations; during which the matter passes from an indefinite incoherent homogeneity to a definite coherent heterogeneity; and during which the retained motion undergoes a parallel transformation.[6]

In this case, the complexity of the conception necessitates words of sharp and definitive meaning; and by such words it is taken out of the realm of the commonplace and made memorable. When, on the other hand, in another definition almost equally celebrated, Dr. Samuel Johnson makes affirmation that a "network" is not, let us say, any regular, comparatively open arrangement of interlacing strands and meshes, but "anything reticulated or decussated, at equal distances, with intersections between the interstices," we, hearing him, do not quite know whether to believe him or not. The one thing definition is not is obfuscation, and Johnson's light is mostly smoke; his conglomeration of vocables itself requires elucidation. Flame out of smoke, not smoke out of flame is our desire. A conception is not

[5] *Scientific American.* January 15, 1916, p. 78.
[6] *First Principles.* Appleton, New York, 1901. Chapter XVII.

always rendered easy of comprehension by couching it in simple words; yet the simple suggests the clear. Of verbal meaning, definition is the true refiner's fire. The best helper a thinking man can have is a wide vocabulary—a vocabulary constantly at his command; but the only words we truly have command of are those words we can define. "Language," Coleridge tells us, "thinks for us." But this is true only of the winged words, the swift, keen, quick words, made so by definition; of the words that come each to its mate—each suggestion finding its response.

But something more might well be said regarding the conventional form of definition. If in their power of illumination they are to resemble arc lights and not tallow dips, they must conform in their arrangement to certain long-established canons of logical composition. In the following section our attempt shall be to throw some light on the technique involved in the handling of these parts, first the subject or given part and the verb of predication, and second the genus and the differentiae.

The subject of a definition must be a noun, either abstract or concrete, common or verbal. Preceding it may come a verbal appositive such as we see in "the *word* 'amortization' means . . .," or "the *term* 'alumina cement' covers. . . ." Inasmuch, however, as this inclusion throws the definition out of its normal intransitive form, or else adds an entire member to the length of the definition, it is generally to be discouraged. The subject, also, may have following it a true appositive, as "an electrical generator, or *dynamo,* is . . ."; and again, it is sometimes accompanied by one or more adjectives as "the *Fahrenheit* degree," "a *periodic* motion," "*natural* or *physical* depreciation," "*velocity* head," "*Ferry* metal," "a *deck* bridge." Such terms as these are, as nouns, definable only to the extent that they may be considered as compounds. A "*sport* model" is a proper subject for definition, but not a "*new* model"; an "*impounding* reservoir" we can define, but not an "*overflowing* reservoir." In this case the genus should, in strictness, take a form not cognate with the subject, "A vacuum tube is a *device* . . .." "the heat engine is a *machine*. . . ." Otherwise, the definition spends its effort on the defining mainly of the adjec-

tive; in which case, it permits in the genus forms cognate with the subject, or pronouns referring to the subject:

meteoric water is *water* . . .
an induction motor is an alternating-current *motor* . . .
a hydraulic-fill dam is *one* in which . . .
igneous rocks are *those* which . . .

Similarly, the subject may be accompanied by phrasal modifiers, sometimes of considerable length,

the load factor *of a machine, plant, or system* is . . .,
the moment of inertia *of a body with respect to an axis* is . . .,
the regulation of a machine *in regard to some characteristic quantity (such as terminal voltage or speed)* is . . .,
the direct capacities of an electrical system *with no given accessible terminals* are defined as . . .[7]

Finally, the subject may take such a phrase of qualification as "A 'bushing,' according to the most common application of the term, is . . .," " 'dry rot' the United States Forests Products Laboratory finds is . . .," " 'Second-foot' as defined by the United States Geological Survey is . . .," "the 'electromagnetic force,' as considered within the scope of this paper, is. . . ." The difference, by the way, should be noted between these phrases and that which we have in "Sanitation as a science is defined as. . . ." In all cases the important consideration in the selecting of a subject is the securing of some definite concept, of some recognizable, determinable entity which in its own nature is capable of circumscription.

The verb in definitions may be merely implied, as regularly in dictionary definitions, and frequently in the formal, especially the listed, definitions of text-books. We observe the verb thus omitted in the following facetious quasi-definition of a sidecar:

Cycle car.—A French contemporary gives the following definition of a cycle car (a species extinct in this country but quite alive abroad); 'Four bicycle wheels, a motorcycle engine, a length of sewing machine belting, and a garden seat.'[8]

The normal intransitive *is* or other form of *to be* may be subtly qualified by such alternatives as,

[7] *Bell System Technical Journal.* Vol. I, No. 1 (July, 1922), p. 20.
[8] *Automotive Industries.* Vol. XLIII, No. 18 (October 28, 1920), p. 879.

"is applied by many persons to," "is here used as," "is used in engineering as," and "may be (can be, has been, will here be) defined as." Such other practically identical locutions as the following are best avoided, as confusing the essential motion of "is": "is defined as," "we may define as," "is the name given to," "is used to designate." Transitive verbs (or better the quasi-transitive verbs of definition), express, first, equivalence, by such words as "means," "expresses," "specifies," "signifies," "refers to"; and second, inclusion, by such words as "includes," "embraces," "consists of." Notice of the verb "is called," found in the reversed form of definitions, appears on page 182. The verb, like the noun (and what we have assumed to be nominal qualifiers may be verbal), may take a limiting modifier; such as we see in "essentially," "in general," "in reality," "in a legal sense," "in steam-engine practice," or, "in its strictly scientific and engineering uses the word 'efficiency' has one well-defined general meaning, namely, . . ."

In any case, the function of the verb is to indicate whether the relation between subject and predicate is one of identity or equivalence or mere inclusion; and then, if necessary, to point out the extent or degree of such relationship.

But the most critical part of a definition, as we have noted, is the genus. This consists of a noun, usually a somewhat generalized word, such as,

> art, science, branch, appliance, process, phenomenon, substance;

or of two nouns:

> "is the mechanical push or pull which is . . . ," "is an act or omission which . . . ," "is an alternating-current motor, either single-phase or double-phase, comprising . . ."

The verbal weight which comes nearest to balancing the subject in our definitory weighing will be a noun; the major fractional make-weights are adjectives—the minor ones being, of course, the restrictive phrases and clauses of the differentiae. The judicious use of an adjective with the genus will oftentimes save much encumberment of details in the differentiae below; examples are;

"Ozone is an *unstable* gas . . ."
"An asset is any consideration *material or otherwise* . . ."
Tar is "*a thick, brown to black, viscous* fluid . . ."

The first principle of definition is that the circumscribing circle of the genus should include in its entirety that of the term defined. Thus we may not in definition say that the slide rule is an "engineering instrument," or that the blackboard is a "slab of slate." Once more, in its part of speech, the genus should correspond to the subject,—noun to noun, verbal to verbal, infinitive to infinitive. For example, "volplaning" is not "to glide down"; "filtration" is not "treating" fluid thus and so; and "to aerate" is not "where" you do anything at all. Clearly, as the grammatical subject of the definition is nominal, this genus word, its predicate equivalent, and grammatical "complement," must likewise be nominal. To say that,

"Work is done when a force is moved through a distance," or,
"Temperature changes are defined as being proportional to the corresponding changes . . .," or,
"The electromagnetic unit e.m.f. exists between two points when one erg of work is done by . . .,"

is not, in strictness, to define at all.

The actual determination of this genus noun often puts thorough knowledge and sound judgment to the test. Is "temperature" a condition, or a degree? Is a "force" an action, or something which determines an action? Is the "moment" of a force a measure of the force, or better perhaps, the ability of the force to accomplish something? Once more, is "inductance" the ability of an electric circuit to do a thing, or is it an action or a property, perhaps, of this circuit by virtue of which it does the thing? Are those easy resources of the lexicographer, "means," and "device," and their still poorer cousin, "something," the closest possible approximations of the word to be defined? But let us consider a few more of the alternatives that may arise to perplex the maker of definitions. Which of the following shall he choose?—well might Portia, the uncanonized patron of all choosers, exclaim over the word 'choose'!

Colloids are matter in a finely divided . . .
Colloids are substances wherein matter exists in . . .

A rheostat is an instrument involving . . .
A rheostat is an adjustable resistance of . . .

Sandstones are rock formations consisting of . . .
Sandstones are grains of quartz which . . .

The watt is the product of one volt by one ampere . . .
The watt is the unit of power equal to the product . . .

The duty of a pump is the number of foot-pounds of work done . . .
The duty of a pump is the amount of work, expressed in number of foot-pounds, done . . .

The value of anything is the power it possesses to command . . .
The value of anything is the quantity of any other . . .

Pasteurization is the heating of fluids for the purpose of checking . . .
Pasteurization is the process of heating fluids to . . . for . . .

Aeration consists in bringing water into contact with . . .
Aeration is the bringing of water into contact with . . .
Aeration is the process of bringing water . . .

The gasometer is an inverted vessel, usually a cylindrical metal one, placed . . .
The gasometer is a measuring instrument, consisting of an inverted vessel, usually . . .

Choice in many of these cases will turn upon the presence or absence of any word that can strictly be taken as the genus. A definition which tends toward the opposite extreme is the following:

"Amiesite is a method, and the paving material, and the pavement resulting from the use of that method." [9]

But one of the most interesting features of many a genus is the modifier in *of* which accompanies it. In certain cases the true genus, that is the equivalent of the subject, is in the grammatical complement; in other cases, it is in the phrasal adjunct of this complement. The student will find it interesting, by the way, to note how different kinds of genitives—e.g., of possession, of constituents, of quality, of specification, of identity, of the object of action, etc.—variously affect this shifting of the logical correspondent of the subject. As examples of the two sorts we may take,

[9] *Good Roads.* Vol. LXVIII, No. 3 (March, 1925), p. 79.

Resistance is the *property* of a conductor that . . .
Sanitation is the *adjustment* of the environment . . .
An ampere is the *quantity* of electricity which . . .
A coping is a *protection* of stone which . . .
A pound is a *unit* of weight . . .
The oersted is the *unit* of magnetic reluctance and is the reluctance of a path that . . .

and over against these

Narration is the type of *writing* that . . .
Mechanics is that branch of *physical science* which . . .
Masonry is a work of *stone and mortar* which . . .
Current is the quantity of *electricity* flowing . . .
A transformer is a form of *apparatus* in which . . .
The Fahrenheit degree is 1/180 of *the temperature interval* between

That this difference is more than academic will be evident to anyone who will study the differentiae, and note their dependence in one case on the complement, in another on its modifier.

Than that forlorn begging of the definition found in the generic makeshifts, "a kind of" or "a sort of," only one thing is worse; namely, to add a second indefinite article after the of. In this type, the subject equivalent has slipped completely over into the phrasal object, leaving us only a partial likeness—a synonymy that admits it is not synonymous.

In closing this section let us stress again the importance of verbal economy. If the reading "A breast-wall is one built to . . ." will serve as well as "The term breast-wall refers to a wall of masonry constructed for the purpose of . . .," we do well to use it. If the word "conveying" in a "conveying tube" conveys no more meaning than "tube" would without "conveying," "conveying" should be conveyed away.

The differentia frequently shows complex verbal arrangements. In this member we are likely to come upon a considerable degree of subordination—and also, at different stages of dependency, upon some little coordination—of component parts. These relationships will best be brought out by use of an analytical, or "display," outline. Such complexity of form implies, naturally, corresponding subtlety

of idea—the notion being carried at each step one stage further into the abstract. Or, if we look at the situation in another light, we see that in extremely abstruse cases it is only by adding phrase on phrase that we are able to reach up or down to the conceptually rarefied level where the idea exists. Consider, for example, the abstracting effect of successive prepositional phrases in the following:

"Power factor may be defined as
  the ratio
      of true power
    to the square root
        of the sum
          of the squares
            of
              the true power
              and the reactive power." [10]

3242 * (1922) **Power Factor.**—Power factor is the ratio of the power to the apparent power.

Or, consider again,

"The derivative
    of a function
  is
    the limit
      of the ratio
          of the increment
            of the function
        to the increment
              of the independent variable,
      when the latter increment
              varies and approaches the limit zero." [11]

Here a glance is sufficient to show us the distance back into abstraction at which the term "limit" has been located by these successive limitations. Or let us take one more case: Reasoning we know; and that in certain definite forms. These forms indeed we can conceive of as having certain well-established outlines—outlines susceptible of investigation; and on such basis we form the definition,

[10] *Journal* of the American Institute of Electrical Engineers. Vol. XXXIX, No. 6 (June 1, 1920), P. 540. See Notes 20 and 31. Cf.—The A. I. E. E. *Report on Standard Definitions,* No. 2 (August, 1927):

* The power factor when both the current and voltage are sinusoidal is equal to the cosine of the angle which expresses their difference in phase. (See Phase Difference; Lead and Lag.)

[11] Granville, W. A., *Elements of the Differential and Integral Calculus.* Ginn and Co., Boston, 1911. P. 27.

Logic is the study
of the outlines
of representative forms
of reasoning.

But how far back does this take us from the world of actuality!

The function of the differentiae, we have seen, is to indicate the nature of the discrepancies between the circumscribing line of the subject and that of its as-closely-as-possible-approximating genus. It marks down for special notice such individual characteristics as among all the members covered by the genus belong to the subject and to it alone. Its business, be it noted, is to tell *what* the subject is, not *where* it is, or *when* it is, or *how* it is. Thus such a sentence as,

"Dielectric absorption is a phenomenon present to some extent in all solid dielectrics, and is practically absent in air." [12]

may contain valuable information regarding a topic without defining it.

The *of*-phrase that as a rule belongs with the genus, almost as though it were a possessive genitive in *'s*, may on occasion serve the purpose of a differentia, as for example in

The fuselage is the body of *an airplane.*
The gilbert is the unit of *magnetomotive force.*

This intimate type we might call the genitival differentia. The form is most frequently found in differentiae which contain some cognate of the subject, as, "The stairhead is the top of the *stair*" (or "of the staircase"). Much more convincing in the rôle of true differentia is a second *of*-phrase modifying the first one, as "Hydrostatics is the science of the pressure and equilibrium of *liquids*." In exceptional cases an extended differentia will be found dependent on this genitival modifier, as appears in,

"The henry is the inductance
of an electric *circuit*
in which a variation
in current
of one ampere
in one second
will induce an electromotive force
of one volt."

[12] *Radio News*, March, 1924, p. 1250.

In the great majority of cases, however, the differentiae depend upon the grammatical genus, not upon its modifier.

Next, we are interested in its own grammatical character. Most rarely, by the ellipsis of a possible relative construction, the differentia appears as an adjective:

> "The foot-candle is the measure of light intensity *incident* at right angles on a plane one foot distant from a light source of one candle power." [14]

Regularly, however, the differentiae appear in some one, or in some combination, of the following constructions, including, of course, any dependent members which these may have; first,

A PHRASE, either in
  the prepositional form with
    a common-noun object, or
    a verbal-noun object ("for . . ing"); or in
  the participial form, either
    present, or
    past; or in
  the infinitival form; or second,

A CLAUSE, either in
  the relative form introduced by
    which is ("has," "does," etc.),
    whose . . . is, etc.,
    in ("on," "of," "for," "by," "by virtue of," etc.)
  the temporal form ("when . . . .," etc.)
    present,
    past; or in
  the spacial form ("where . . ," etc.)

These primary modifiers of the genus may, in turn, any one of them take one or more modifiers either like itself or in any of the other forms. Hence rises the possible complexity of definitions of which we earlier spoke. Fortunately, however, complexity does not necessarily imply vagueness and confusion; and the beautiful order that distinguishes the effective definition becomes apparent when its structure is analyzed.

[14] *American Architect.* Vol. 113, No. 2200 (February 20, 1918), P. 215.

"Heat-Treatment.—
The change,
or the series of changes,
in
temperature
and also the rate of change
from
one temperature
to
another,
brought about to secure
certain desired
conditions
or properties
in a substance."[15]

"A contract is
a voluntary agreement,
between
two
or more
competent parties,
for valid consideration,
to
do
or abstain from doing
some lawful act."[16]

"A force is one of a pair of
equal,
opposite,
and simultaneous
actions
between two bodies
by which
the state
of
their motion
is altered,
or a change in the form
of
the bodies themselves
is effected."[17]

[15] *Journal* of the Society of Automotive Engineers. Vol. XIV, No. 4 (April, 1924). P. 384.

[16] Allen, C. F., *Business Law for Engineers.* McGraw-Hill Book Co., Inc., New York, 1919. Chap. III.

[17] Jameson, J. M., *Elementary Practical Mechanics,* 2nd ed. John Wiley & Son, Inc., New York. P. 4.

"Value is a term used by the older political economists to denote
the number
    of units
        of
            one class
                of
                    goods
                    or services,
            A,
    that can be exchanged for a given
                        unit
                        or number
                            of units
                                of
                                    another class
                                        of
                                            goods
                                            or services,
                                    B." [18]

"Plasticity is
    the ability
        of a body
    to undergo
            dislocation
                of its smallest structural
                        particles,
            as a consequence
                        of the application
                                of external
                                    forces,
                        at ordinary temperatures,
        without disturbance by their coherence." [19]

"An emulsion may be defined as
    a mixture
        of two non-miscible liquids,
    in which one of them
            is evenly
                distributed
                or suspended
                    in the other
                as small discrete particles . . .
the finely divided
    particles
        are called
            the internal
            or disperse
                phase,

and the surrounding liquid
medium
the external
or continuous
phase." [20]

•

Power factor in a term
which
describes
the flow
of energy
in an alternating current circuit
and which
expresses
a relation
between
the amount
of energy
converted
into
heat
or mechani-
cal work,
and the amount
of energy
periodically
absorbed
and discharged

the circuit.[21]

"The hearth is
the crucible
or lowest section
of a blast furnace,
where
the molten
metal
and slag
are collected." [22]

Among the faults peculiar to the differentia we might mention the obvious one of failing adequately to cover the characteristics of the class. This we see in

and again we see it in Wellington's famous "definition":

> "In a certain important sense it [Engineering] is rather the art of not constructing; or, to define it rudely but not inaptly, it is the art of doing that well with one dollar, which any bungler can do with two after a fashion." [24]

Another fault is back-reference by such a nominative-absolute construction as "its distinguishing feature being . . . ," wherein "it being," etc., refers not to the genus but to the subject; e.g.,

> "The mineral filler, which is added after the hydrated lime, and just before the batch is dumped, is really a part of the mineral aggregate, it being fine crusher grit." [25]

Another cause of ineffectiveness is lack of parallelism, as where we speak of a thing as being,

owned
        by a specific business enterprise.
and of value
        to that enterprise,

instead of speaking of it as a thing

owned
and valued
        by a specific business enterprise.

Finally, in this section as in every other, we must be constantly on our guard against the intrusion of unnecessary words. What passes acceptably as a statement of fact with forty words,

> "The term alumina cement is here used as a convenient designation for the high alumina fused cements which are now made and sold on a largely increasing scale under the trade names of *ciment fondu, Alciment, ciment electrique,* and others,"

would as definition be doubtless reduced to half as many:

> Alumina cements are the high alumina fused products passing under such names as *ciment fondu, Alciment,* and *ciment electrique.*

A well-defined and most interesting type of definition, or perhaps better, description, begins usually with a temporal or conditional clause and leads through an "is called" either

expressed or potential to what would normally be considered the subject, and what may easily be made the subject by a transposition of material. Examples of this type are found in the following:

> "Two equal, parallel, and opposite forces are called a couple; the perpendicular distance between the forces is the 'arm' of the couple." [26]

> "A sine wave having the same effective value, that is, the same square root of mean squares of instantaneous values, as a general alternating wave, is called its corresponding 'equivalent sine wave.'" [27]

> "If through a fixed point P_1 any number of secants be drawn to a circle, and tangents to the latter be drawn at the points of intersection of each secant with the circle, then each pair of tangents will intersect upon a straight line called the polar of P_1. Reciprocally, P_1 is called the pole of the straight line." [28]

> "When a circle, tangent to a fixed circle internally, rolls upon it, the path described by a point in the circumference of the rolling circle is called the hypocycloid." [29]

To say that this form is simply the normal type of definition wantonly or whimsically reversed is scarcely to do justice to the situation. The occurrence of the form is far too general for this, particularly in the upper ranges of the mathematical and physical sciences, where, if anywhere, reason may be said to rule. Now we note that in all *bona fide* cases of this sort we have the specific description of one particular condition or situation. May not this situation be considered the logical subject, and, in fact, the thing to be defined—the thing which is defined, as regards nomenclature, by the affixing to it of a label, a name.

Where we have a succession of related cases falling under a single general head, this type of definition seems far more natural and effective than does the normal type. Thus at the beginning of Chapter VI of Bailey and Woods' *Analytic Geometry*, we read:

[26] Merriman, M., *Civil Engineers' Handbook*, 4th ed. John Wiley & Sons, Inc., New York, 1920. P. 1453.

[27] Steinmetz, C. P., *Theoretical Elements of Electrical Engineering*, 4th ed. McGraw-Hill Book Co., Inc., New York. P. 107.

[28] Bailey and Woods, *Analytic Geometry*, Ginn & Co., Boston, 1897. P. 111.

[29] Nichols, E. W., *Analytical Geometry*, revised ed. D. C. Heath & Co., Boston, 1892. P. 211.

"A conic section is the locus of a point which moves so that its distance from a fixed point, called the focus, is in a constant ratio to its distance from a fixed straight line, called the directrix.

"The constant ratio is called the *eccentricity* of the conic section, and will be denoted throughout this book by the letter e . . . *If* $e < 1$, *the conic section is called* an **ellipse**; if $e = 1$, *it is called a* **parabola**; if $e > 1$, *it is called* an **hyperbola**."

Similarly in Wentworth and Smith's *Plane and Solid Geometry,* at the beginning of Book VII, we have a series of "reversed" definitions of polyhedron, § 500; section of polyhedron, § 501; convex polyhedron, § 502; prism, § 503; altitude of a prism, § 504; right prism, § 505; oblique prism, § 506; right section, § 508; and truncated prism, § 509. This series would appear altogether orthodox if the *initial* definition upon which the others were based had been arranged in the normal isolated form of definition: "A *polyhedron* is a solid bounded by planes," instead of in reversal.[30]

An exceedingly interesting definition, from the point of view of arrangement, is the following one of "power factor," wherein the formal definition is saved climactically until the end, just as was the main term in the type we have just considered:

"Power factor is a term which describes the flow of energy in an alternating current circuit and which expresses a relation between the amount of energy converted into heat or mechanical work, and the amount of energy periodically absorbed and discharged in the circuit. [*Thus far we have description, not definition.*] Power factor is not the simplest factor related to true power and reactive power, but it is a convenient factor, as it expresses a ratio between the amount of power actually delivered in a circuit, to the amount of power which might be delivered without exceeding the same heating. [*Still description, though approaching closely to definition.*]

"Power factor may be defined as the ratio of true power to the sum of the squares of the true power and the reactive power. [*True definition, most effectively introduced.*]

$$P.F. = \frac{P}{\sqrt{P^2 + Q^2}}$$

In the above expression, P is the algebraic sum of the watts, and Q is the algebraic sum of the reactive watts in all of the component parts of the circuit." [31]

[30] Wentworth, George, and Smith, D. E., *Plane and Solid Geometry.* Ginn & Co., Boston, 1913. Pp. 317–318.

[31] *Journal* of the American Institute of Electrical Engineers. Vol. XXXIX, No. 6 (June, 1920). P. 540.

This definition reminds us that beyond a certain point verbal definition no longer can suffice, either because of the subtlety or complexity of the conceptions expressed, or because of our desire for exactness. At this point, however, the scientist, pure, or applied, has easy recourse to one of his other languages, that of mathematics, or that of chemical formula, or that of graphs. To the writer in words, however, this recourse is denied. Where his interest is in facts not in words, he most frequently proceeds by making the best definition he can obtain the starting of a discussion in which by successive modification he at length arrives at some statement which will approximate his need.

The transition from strict definition to descriptive talk is by slow degrees. From reversed definition, for instance, we advance to comments on terms of loose classification. Or we get non-definitory statement as in the following sentence from the *Scientific American* which a slight rearrangement would change into the form of true definition:

> "The aurora borealis is produced by the action of electric radiation from outer space upon the upper atmosphere."
>
> Cf., The aurora borealis is a phenomenon of the upper atmosphere produced by the action of electric radiation from outer space.

Or, to take another example of definition effected by a slight rearrangement of material:

> "The approximate horsepower that may be transmitted by a belt can be determined by multiplying the effective pull in pounds per inch of belt width, by the width of the belt in inches and the speed of the belt in feet per minute and dividing the product thus obtained by 33,000."
>
> Cf., The approximate horsepower of a belt is the quotient obtained by dividing the product of the width of the belt in inches, the speed of the belt in feet per minute, and the effective pull of the belt in pounds per inch of width, by 33,000.

In this whole matter, the important thing, of course, is not that we should always explain by means of a definition, but that we should know when we are defining and when we are not; and that when definition is what we need we should be able to compose one in that manner which is most effective. Again and again, for the sake of greater clearness we find definitions merging into non-definitory explana-

tion. One serious shortcoming of definition as a whole is that it does not sufficiently present to sense. It does not complete an impression, and bring realization to supplement intellectual grasp. Thus in surveying we may define a "bearing" as "the smaller of two horizontal angles between the direction of a line and the direction of a meridian." Here is the whole story, full enough for all purposes of classification; but if we go on to tell the student that "it is measured from the north or from the south, toward the east or toward the west," and if we add the supererogatory information that "its limiting values are 0° and 90°," or even bring in for comparison some reference to azimuth, we shall contribute materially to the picture of the situation present in his mind. As Professor Ashley H. Thorndike observes, "Any precise and compact definition is sure to lack in comprehensiveness and veracity. It cannot sum up the facts of the past and present, much less set rules for the future." [32]

Thus to the technical man the dictionary is the court of first resort rather than that of last; a work of reference quite possibly proving far more valuable for its spellings than for its technical meanings. He knows as does the lawyer what a test is brought upon definition as upon any classification by infinitely intergrading cases. All too frequently the dictionary does not go far enough to meet his need. When this first recourse fails to satisfy his requirements, he may seek out books or periodicals wherein recognized authorities have expressed their understanding of the term as it is used under recent or highly specialized conditions. Then he may be so fortunate as to find an acceptation standardized by some official body, a meaning coming as from a court of final appeal. But failing in both these directions, he still has expedients at his command. In the following section we shall touch on some of these supplementary devices.

Definitional Description

In taking up this process of supplementary explanation we shall give our attention first to the attempts to throw

[32] *Tragedy.* Houghton Mifflin & Co., Boston, 1908. P. 12.

added light on the use of the word, and then to those that bend their energies to an interpretation of the idea. We first, accordingly, consider the term to be defined with a view to seeing what its significance ought to be.

Not infrequently we shall find it profitable to examine the derivation, or etymology, of a word to be defined for hints regarding the symbolic values inherent in its elements. One with but a poor pennyworth of Latin can guess to good purpose at the meaning of "monomania"; and a person with but little more Greek can surmise pretty closely the signification of "schidzophrenia." Thus any definition of "engineer" or "engineering" would naturally refer to its origin in the Latin *ingenium*. Again, A. McL. Nicolson begins an article in the *Proceedings* of the American Institute of Electrical Engineers:

> "The expression *piezo* is derived from the Greek 'piezein' signifying 'to press.' It relates to a variety of solids in the crystalline state, which when subjected to a change of stress, become electrically polarized." [33]

Similarly, Dr. Benjamin Horowitz explains "enzyme" in the *Scientific Monthly* as follows:

> "The word *enzyme* comes from a Greek word meaning 'in yeast' (*en*, in; *zyme*, leaven). Perhaps the most acceptable definition in the light of recent scientific research is to say that it is a substance showing the properties of a catalyst and produced as a result of cellular activity." [34]

Another device supplementary to definition is that of expansion or iteration with substitution or amplification of terminology. This we may illustrate by a definition of "concrete," given to illustrate "a not infrequent error in pavement type nomenclature," i.e., "the use of the word 'concrete' without any other qualifying designation":

> "The definition as given by the Century dictionary reads: 'A compact mass of sand, gravel, coarse pebbles or stone chippings cemented together by hydraulic or other mortar, or by asphalt or refuse tar.' This definition has been supported and substantiated by court decisions from which it is found that concrete aggregates may consist of crushed stone, gravel, sand, cinders, furnace slag or a

[33] Vol. XXXVIII, No. 11 (October 9, 1919). P. 1315.
[34] Vol. VI, No. 3 (March, 1918). P. 253.

combination of these, and the cementing material may be portland or natural cement, asphalt or tar. Correctly speaking, a 'concrete' pavement may, therefore, be any one of a score of designs, including asphaltic concrete, portland cement concrete, or bituminous concrete cemented with tar." [35]

We shall better understand the name of a thing if we view it in conjunction with other names. These may be similar in their nature, or they may be different. Thus the "drop shape" of aeronautics has been likened to the "streamline shape" of the automotive industry. A writer in *Mechanical Engineering* thus makes use of analogy to explain the "springing" of elastic bodies:

"The noun 'spring' is applied in various senses to things in which an automatic or spontaneous movement, i.e., 'springing,' takes place. Such things are, the season of the year in which plants begin to spring forth, the wells of water which spring from beneath the earth's crust, and the 'elastic' bodies which have the property, within certain limits, of springing back when deformed. In every case there is an inherent force which causes the 'springing,' being, for the first case, chemical energy, for the second, hydraulic pressure, and for the third, 'elastic force.' 'Elastic' is derived from a Greek word meaning 'to drive,' the driving now being recognized as the electromagnetic or similar type of attraction between atoms not in a state of equilibrium. Nearly all materials, whether they be organic or inorganic, particularly metals and rubber, possess electricity." [36]

A writer on Chinese irrigation explains the treadmill as follows: a treadmill

"is similar to an overshot wheel, working as a pump, set in an inclined position to suit the lift of the water required. The operator or operators tread the projecting arms of the axle, thus turning the vanes and lifting the water through the trough." [37]

Another author, after holding up for enlightening comparison the dictionary definitions of "economy" and "efficiency," concludes that they "embrace the same qualities and, taken together, add nothing" to each other.

But of far more frequent recurrence than comparison and analogy are antithesis and contrast. The latter is an

[35] Letter to *Engineering News-Record.* Vol. 85, No. 19 (November 4, 1920). P. 908.

[36] Vol. 46, No. 11a (November, 1924). P. 794.

[37] *Engineering News-Record,* Vol. 85, No. 13 (September 23, 1920). P. 619.

attempt to sharpen definition by telling what a thing is not, by the method of elimination. As a typical example of such qualification we might refer to a definition of "the function of a ship," wherein we read,

> "The most successful vessel is that which obtains the greatest power of transportation at minimum cost. Power of transportation may be defined as the quantity carried per unit of time. It is not sufficient for a vessel to carry a certain deadweight alone, but it is necessary that such weight be transported at a given speed, and that the relation of capacity to deadweight be such as to utilize the maximum draught which the dimensions and strength of the vessel permit." [38]

Sometimes the aim of contrast is to clear up possible confusion arising from such cognate words as "capitalization" and "capital," "capacity and capability," "valence" and "valency," [39] or "the spreading rate" and "spreading power" of paint.[40] At other times, the aim is to distinguish terms whose ideas bear more resemblance than do their outward form. Such as,

> "Schedule is distinguished from inventory. A schedule is a list of items; an inventory is the schedule with prices or values attached to the items." [41]

Here, also, we may bring to mind the possibility of clarifying a subject by criticizing existing definitions. A splendid example of this, defining "Labour," occurs in W. S. Jevons' *The Principles of Economics*.[42] Again a writer in the *Engineer*, in discussing "saturated steam," comments on,

> "the extraordinary game of cross purposes which has been produced by the term 'saturated steam,' for no less than sixteen totally different definitions have been accepted at different times by different people."

"Do all the values," he asks, "stated in the accepted steam tables for the total heat, the latent heat, and the volume apply to steam which is definitely, accurately, and scien-

[38] *Scientific American Supplement*, May 11, 1918. P. 302.
[39] *Scientific American Supplement*, October 27, 1917. P. 272.
[40] *Standards*, American Society for Testing Materials, 1916. P. 591.
[41] William G. Raymond, *The Public and Its Utilities*. John Wiley & Sons, Inc., New York, 1925. P. 292.
[42] The Macmillan Co., 1905, pp. 72–76. A passage quoted in *Freshman English* by Frances B. and Karl Young, Henry Holt & Co., New York, 1914. P. 281.

tifically steam?" and after answering his own question in the negative, he proceeds to a re-defining of these terms, and together with them "sensible heat in steam," "total heat in steam," "wet steam," and "superheated steam." [43] Another excellent example of this elucidation of the different meanings of a word is found in Baker's *Masonry Construction:* "Unfortunately there is an ambiguity in the use of the word *caisson,*" in which definition we have a distinguishing of the older uses of the term and the more recent, together with a differentiating of the inverted, or pneumatic, type and the erect type, or coffer-dam; and of both of these from the open caisson.[44]

Attention to the Idea Expressed in the Word

But besides attending the *word,* we may attend the *idea* implicit in the word. Here we shift over toward explication, as it is used in a sentence of John Stuart Mill:

> "The discussion of definitions, in so far as it does not turn on the use of words, but on the properties of things, Dr. Whewell calls the *explication* of conceptions." [45]

Here we may either examine into the content of the idea or enlarge on the genesis or behavior of the idea.

The most obvious way to indicate the nature of a thing is to point to some example. A definition of "value," for instance, is effectively followed by the sentence, "Thus the value of an ox may be ten sheep." A. W. Duff illustrates "periodic motion" by reference to the motions, first, of the moon; then, of the tip of the hand of a clock; and lastly, of a point on the vibrating string of a violin or a piano.[46] As larger instances of the use of such exemplification we may take the following from an article by Mr. Charles W. Gibbs appearing in the *Compressed Air Magazine*:

> "Refrigeration, or the artificial production of low temperatures, resolves itself into the problem of removing heat from the body to be cooled and of transferring it to some other body where it will have no undesirable influence. The home ice-cream freezer is a

complete refrigerating plant. The can containing the material to be frozen is packed in ice and so rotated that the contents are stirred and all parts of the can are brought into intimate contact with the ice. The heat of the can and its contents passes to the ice which of course melts."[47]

"The term lumen is comparatively new but is adopted as a necessity in these calculations. The lumen is a measurement of the *quantity* of light while the foot-candle is the measure of the *intensity* of light. We are familiar with the rating of lamps in the terms of watts. The watt, being a measure of electrical energy, is not a measure of illumination. The watt, then, is a factor in the cost of light rather than in the quantity of light. The amount of light emitted by an electric lamp is not in proportion to the watts consumed and it is therefore necessary to rate the lighting ability of a lamp in terms of lumens.

"When a uniform light source of one candle-power is at the center of a sphere of one foot radius, the intensity of illumination is one foot-candle at every point on the interior of the sphere. The area of the surface of such a sphere is 12.57 sq. ft. (4π) and the term lumen denotes the quantity of light received on each square foot of the surface of the sphere. Or the lumen is the quantity of light received from a source of one candle-power upon a surface of one square foot, every point of which is one foot distant from the light source. Hence a light source of one spherical candle-power will produce an intensity of one foot-candle over 12.57 sq. ft. or 12.57 lumens. One lumen is emitted oy 0.07958 spherical candle-power."[48]

But verbal exemplification is not sufficient to meet fully the requirements of understanding. Like the "fundamental image" in description, or like the actual "illustration," it merely serves the purpose of giving an immediate, comprehensive, and fairly adequate idea. But just as we need to supplement the photograph by the schematic drawing, so often we need to support the example by particularization and analysis—by analysis and classification, by classification and the catalogue. In a word, we must come to know the thing to be defined "as in itself it really is." John Stuart Mill remarks most pertinently, in commenting on the great diversity in the current acceptations of logic:

"It is not to be expected that there should be agreement about the definition of anything, until there is agreement about the thing itself. To define is to select from among all the properties of a thing those which shall be understood to be designated and declared by its name; and the properties must be well known to us before we can be competent to determine which of them are fittest to be chosen

for this purpose. Accordingly, in the case of so complex an aggregation of particulars as are comprehended in anything which can be called a science, the definition we set out with is seldom that which a more extensive knowledge of the subject shows to be the most appropriate. Until we know the particulars themselves, we cannot fix upon the most correct and compact mode of circumscribing them by a general description." [49]

The method of analysis is shown in the following examples:

"Time study is that function of management which, by analysis, dissects the factors involved in the actual production of goods; and, by synthesis, shows the method and determines the time for producing the goods most favorably." [50]

With this case where the analysis is within the definition, compare the following:

"Evidence, in a legal view, is the means by which any alleged fact is established or disproved. There are two important sides or features of evidence; first, its 'competency'; second, its 'weight.' Competent evidence is that which is appropriate in its nature as a means of proof. Satisfactory or sufficient evidence is that amount of 'weight' of evidence which is adapted to convince a reasonable mind." [51]

"Cost has two meanings, one quite elementary and the other more complex.

"In its elementary sense, the cost of a thing to a given owner is the sum of the prices, or total price, paid or payable by that owner at the time the thing was acquired. This may be called 'elementary cost.'

"In its broader sense, the cost of a thing to a given owner at a given time is the sum of all net debits chargeable to the thing up to the given time including the value of the owner's time. This cost may be said to be 'economic cost,' in order to distinguish it from 'elementary cost.'

"Sacrifice cost is the payment (interest, supervisory wages, depreciation annuity and risk insurance) foregone during the period that a business is being developed or built up to a point where it earns a normal return on the investment. Sacrifice cost may therefore include interest during construction as well as its sequel, development cost or accumulated deficit in fair return on the investment." [52]

[49] "On the Definition and Province of Logic," *System of Logic.* Harper, 1873.

[50] *Industrial Management,* Vol. LXVII, No. 3 (March, 1924). P. 145.

[51] Allen, C. F., *Business Law for Engineers.* McGraw-Hill Book Co., Inc., New York, 1919. Chap. II.

[52] *Engineering and Contracting,* Vol. XLVII, No. 5 (January 31, 1917). P. 95; Cf., Vol. XLVII, No. 9 (February 28, 1917). P. 196.

Sometimes old distinctions fall into abeyance as appears from the following:

> "*Puddling.*—The process of making wrought iron by oxidizing and removing most of the silicon, carbon, manganese and phosphorus contained in pig iron in a reverberatory furnace. "Puddling" formerly was applied only to the practice of employing refined pig iron and "Pig Boiling" was the name applied when unrefined pig iron was used, but now this distinction is not generally made as the pig iron is seldom refined. Puddling as practiced to-day is really pig boiling."[53]

As examples of enumeration, or the catalogue type of analysis, first in the differentia itself, and then in the supplementary text, we may take the following:

> "Asphalt.—Solid or semi-solid native bitumens, solid or semi-solid bitumens obtained by refining petroleums, or solid or semi-solid bitumens which are combinations of the bitumens mentioned with petroleums or derivatives thereof, which melt upon the application of heat, and which consist of a mixture of hydrocarbons and their derivatives of complex structure, largely cyclic and bridge compounds."[54]
>
> "The term 'Grading' shall include all cuts, widening of fills, ditches, drains, borrow-pits, approaches, and all dirt moving, for whatever purpose connected with the work, where such work is an essential part of, or necessary to, the prosecution of the contract. It shall also include, unless otherwise specified, all necessary grubbing, clearing and disposing of wood or stumps, or removing of fences or other obstructions from the work."[55]

Just as the preceding example illustrates the typical manner of definition in specification writing, so the following lengthy compilation exhibits the more legalistic form of definitional enumeration. This is from a typical law for the registration of professional engineers, drafted in February, 1915, by a joint committee of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American

[53] From "Standard Definitions of Terms Relating to Wrought-iron Specifications (Serial Designation: A 81–27)," in the 1927 book of A. S. T. M. Standards, Part 1. American Society for Testing Materials. P. 410.

[54] *Transactions* of the American Society of Civil Engineers, in "Final Report of the Special Committee on Materials for Road Construction and on Standards for their Test and Use." Vol. LXXXII, December, 1918. P. 1420.

[55] *Report* of State Highway Commissioner of Michigan (1912). P. 108.

Institute of Mining Engineers, the Society of Naval Architects and Marine Engineers, and the American Institute of Consulting Engineers.

> "A person practices professional engineering within the meaning of this act who practices any branch of the profession of engineering other than military engineering. The practice of said profession embraces the design and the supervision of the construction of public and private utilities, such as railroads, bridges, highways, roads, canals, harbors, river improvements, lighthouses, wet docks, dry docks, ships, barges, dredges, cranes, floating docks and other floating property, the design and supervision of the construction of steam engines, turbines, internal combustion engines and other mechanical structures, electrical machinery and apparatus, and of works for the development, transmission or application of power, the design and the supervision of mining operations and of processes and apparatus for carrying out such operations, and the design and the supervision of the construction of municipal works, irrigation works, water-supply works, sewerage works, drainage works, industrial works, sanitary works, hydraulic works and structural works and other public and private utilities or works which require for their design or the supervision of their construction such experience and technical knowledge as are required in Section 8 of this act for admission to examination. The enumeration of any public or private utilities or works in this section shall not be construed as excluding any other public or private utilities or works which require such experience and technical knowledge for their design or the supervision of their construction. The execution as a contractor of work designed by a professional engineer or the supervision of the construction of such work as a foreman or superintendent for such a contractor shall not be deemed to be the practice of professional engineering within the meaning of this act." [56]

For another example of a definition which came under the attention of the law, see "belt course," one of sixty or seventy definitions of terms occurring in concrete design and construction, found in *Engineering and Contracting,* Vol. XLVII, No. 9 (Feb. 28, 1917), p. 206.

Occasionally definition becomes a general talking about an idea, not in any strict sense either comparison or contrast, or exemplification or analysis, but partaking in its several parts of all of these elements.

Two characteristic aspects of this type are the definitions effected, first, by talking of the general composition of the thing in question; and second, by saying something about its

[56] *Engineering and Contracting,* Vol. LIV, No. 4 (July 28, 1920). P. 97.

formation or its action. As an example of the first sort we have,

> "Brown coal is a substance intermediate in its nature between peat and ordinary coal. Formed in comparatively recent geological times, Tertiary or Cretaceous, it has not yet developed into a true coal. Peat contains 80 to 90 per cent of water from which it parts with great reluctance; it cannot be separated by pressure. Brown coal or lignite has 20 per cent to 60 per cent of moisture, common coal 2 per cent or 3 per cent."[57]

As other interesting examples of this *genre* we mention an unusually full definition of "sleet" in the *Scientific American* for June 17, 1917, p. 634; a definition of "quicksand" in *Engineering News-Record* for September 16, 1920 (Vol. 85, No. 12), p. 543; one for "dry-rot" in *Engineering News-Record* for July 1, 1920 (Vol. 85, No. 1), p. 11; and finally one for "allotropy" in the *Scientific American Supplement,* January 1, 1916, p. 6.

As definitions effected by commenting on the reactions or on the process of manufacture of a substance, we suggest one beginning, "But what is a catalyst?" to be found in the *Scientific Monthly* for March, 1918 (Vol. VI), p. 253; and another dealing with Vitrolite, appearing in the *American Architect,* Vol. CXIV, No. 2222 (July 24, 1918), p. 126.

In all these ways people have striven to clear up the meaning of their words, realizing that these words are valuable to them in direct proportion as they exactly symbolize some definite thing. As our notions extend in number and develop inwardly in definiteness of concept, so our vocabulary undergoes a corresponding change in extent and exactitude. Hard after the nomenclator must ever come the lexicographer; and on both rests heavy responsibility—not to multiply words unnecessarily, and not to leave in dubiety such terms as are admitted and remain in use. The word-maker must use judgment as to whether an old word is still able to bear the burden of a new meaning, and as to what form the new word, if one be required, best should take. He should guard against duplication of terms where no sig-

[57] *Scientific American Supplement.* Oct. 20, 1917. P. 255.

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> "Brown coal is a substance intermediate in its nature between peat and ordinary coal. Formed in comparatively recent geological times, Tertiary or Cretaceous, it has not yet developed into a true coal. Peat contains 80 to 90 per cent of water from which it parts with great reluctance; it cannot be separated by pressure. Brown coal or lignite has 20 per cent to 60 per cent of moisture, common coal 2 per cent or 3 per cent." [57]

As other interesting examples of this *genre* we mention an unusually full definition of "sleet" in the *Scientific American* for June 17, 1917, p. 634; a definition of "quicksand" in *Engineering News-Record* for September 16, 1920 (Vol. 85, No. 12), p. 543; one for "dry-rot" in *Engineering News-Record* for July 1, 1920 (Vol. 85, No. 1), p. 11; and finally one for "allotropy" in the *Scientific American Supplement,* January 1, 1916, p. 6.

As definitions effected by commenting on the reactions or on the process of manufacture of a substance, we suggest one beginning, "But what is a catalyst?" to be found in the *Scientific Monthly* for March, 1918 (Vol. VI), p. 253; and another dealing with Vitrolite, appearing in the *American Architect,* Vol. CXIV, No. 2222 (July 24, 1918), p. 126.

In all these ways people have striven to clear up the meaning of their words, realizing that these words are valuable to them in direct proportion as they exactly symbolize some definite thing. As our notions extend in number and develop inwardly in definiteness of concept, so our vocabulary undergoes a corresponding change in extent and exactitude. Hard after the nomenclator must ever come the lexicographer; and on both rests heavy responsibility—not to multiply words unnecessarily, and not to leave in dubiety such terms as are admitted and remain in use. The wordmaker must use judgment as to whether an old word is still able to bear the burden of a new meaning, and as to what form the new word, if one be required, best should take. He should guard against duplication of terms where no sig-

[57] *Scientific American Supplement.* Oct. 20, 1917. P. 255.

nificant difference of meaning exists; and above all he should hold as anathema all anomalous coinages standing for nothing in particular and therefore incapable either of definition or of any exact use. He should not, for instance, introduce the term "tensile hardness," if it be true as a writer in the *Engineer* for September 21, 1917, insists, this expression adds nothing of significance to the older and well-known word "tenacity" (page 255). A seemingly more justifiable case of word coinage, by the way, is given in the *Scientific American Supplement* of January 20, 1917, p. 43:

> "Regarding the terms 'strength' or 'intensity' as applied to sparks for ignition purposes, no clear meaning is or can be attached to them. The terms are unsuitable because as ordinarily used they refer to the total heat energy of a spark, and this alone does not determine the ability of a spark to ignite a given gas mixture. To meet the difficulty, the term 'incendivity' has been proposed by the writer to denote the property whereby a spark produces ignition of a combustible gas. The term is convenient for descriptive purposes, but no quantitative definition can yet be given."

Such is the genesis of a word. The extent to which this word or any other can be defined is exactly proportional to the sharpness and positiveness of the mental image of the idea for which it stands. With every inner or outer development of this idea, comes, as has already been intimated, the endless necessity of revising or adding to the definition.

Thus the literature of definition, whether viewed from the angle of art or of science, of economics or of statescraft, or from any other angle, is a literature no less fascinating than it is important. Dr. Johnson's definition of lexicographer, "a writer of dictionaries, a harmless drudge," fails utterly to express an altogether proper degree of pleasure to be derived from what Dante might call the "panther quest" of the elusive definition. Truly nothing is more protean; all writers of definition should surely invoke the aid, and bespeak the patronage, of Mercury himself.

Enough has been said to indicate that definition even at its best must fall short of ideal perfection. As Josiah Royce says, "Definition, simple, positive, hard and fast as it is, never tells the whole truth about a conception."[58] Its π must ever be the approximate $3\frac{1}{7}$, not 3.141659, etc., etc.,

etc. Never can it hope to do away with the incommensurability of words and things. Its correctness and sufficiency, therefore, must at best be relative rather than absolute. The degree of accuracy actually sought will be determined by the demands of the situation in which a word is to be used. Knowledge, good sense, and industry in the framer of a definition will usually, however, suffice to meet fairly well the requirements even of the acid test of actual experience. Ordinarily extremes of exactness and exhaustiveness are not required; this should not, however, be interpreted as a patent for careless, slipshod work. When a person defines "elongation" as "It's a measure of length," or "Why, you stretch something"; or, let us say, interprets it as "To draw out, to elongate," he has not satisfied the requirements of even reasonable approximation. Information, so far as it goes, must be correct; expression must throughout conform with established usages. Beyond this, reason will come to its support, and this under all the stress and strain of actual conditions. No easy task—to make interpretation not only foolproof and rogueproof, but proof against misunderstanding by human beings altogether honest and sincere and rational. Perfect definitions, truly, like Plato's *noumena,* exist only in the heaven above; therefore, of the making of definitions, as of the making of books, there can be no end. In the using of definitions one should always remember that theirs is no ultimate authority. The definition owes all its force to its accurate representing of ulterior fact; behind the shortest word lies often a whole history.

Exercise.—*Terms for definition.* When looking up a word for the first time, do more than glance at its first meaning. Consider also its derivation; the range of its use; the definiteness of its signification; its closest synonyms; its spelling, and pronunciation; its possible use in a sentence.

1. dictionary, glossary, thesaurus, etymology, derivation, nomenclature, terminology, vocabulary, denotation, connotation, synonym, antonym, homonym, idiom, locution, barbarism, impropriety, solecism, colloquialism, slang.

2. Aceldama, aposiopesis, archididascalos, contadine, cothurnus, diachylon, epithalamium, foisonless, genethliacon, hebdomadal, jorum, latten, nympho-

[58] Webster's *New International Dictionary* under "definition."

lepsy, orgeat, palingenesis, prunella, rhabdos, rhodomontade, tellurian, threnody.

3. agency, chattel, contract, consideration, conveyance, damage, deed, franchise, indorsement, injunction, insolvency, lien, mortgage, negotiable instrument, nuisance, prima facie, responsibility, security, title, trespass.

4. accounting, amortization, assets, bond, capital, stock, collatéral, common carrier, cost allocation, demurrage, draft, depreciation, funded debt, lease, liquidation, overhead, cost, realty, security, tariff, utilities, valuation.

5. abutment, architrave, ashlar, buttress, cantilever, conduit, coping, entablature, entresol, façade, intrados, mullion, pediment, pilaster, portico, reredos, sgraffiato, spandrel, trestle, truss.

6. acceleration, adiabatic, aileron, ajutage, algae, allotropic, alluvium, amalgam, anaerobic, anneal, aneroid, azimuth, baffle, berm, bloom, calcination, calibration, calorie, candlepower, case-harden.

7. catalyst, cellulose, centripetal, chassis, coagulation, colloid, coulomb, countersinking, density, diaphragm, dielectric, dynamometer, elasticity, electrostatic, electrolysis, electrolyte, energy, entropy, equilibrium, erg.

8. fireproof, fleche, flux, force, fracture, friction, fuliginous, function, gangue, gauss, geodesy, gneiss, gradient, gumbo, gyration, head, heat, horsepower, hydrolysis, hydrostatic.

9. hysteresis, impact, impulse, incandescence, induction, inertia, infrared, insulation, ion, isoprene, isotherm, ketone, kinetic, knure, laitance, littoral, macadamize, mass, matrix, matte.

10. maxwell, metallurgy, molecule, moment, momentum, ohm, oscillation, oxidation, parabolic, periodicity, permeability, planish, plasticity, polarity, polymerize, polyphase, potential, power, pressure, profile.

11. radiofrequency, reaction, resistance, red-shortness, resilience, resistivity, rigidity, rupture, sanitation, schist, sedimentation, seiche, self-inductance, shear, siphon, site, solenoid, spectrum, speise, static.

12. strain, stress, sump, superheating, suttle, synchronize, tachometer, tare, tenacity, tension, terrain, thermit, thrust, till (*Geol.*), tolerance, torque, traction, trajectory, tret, trituration.

13. agonic line, artesian well, belt course, bench mark, bending moment, brake horsepower, compressive strength, contour line, cross-sectional area, datum plane, dead center, deflection angle, deleterious matter, dielectric substance, differential leveling, elastic limit, electric steel, electromotive force, expansion joint, field excitation.

14. geodetic survey, grade resistance, ground water, high-resistance wire, high-speed steel, high-tension steel, hydraulic ram, incipient fusion, indicated horsepower, indirect lighting, internal-combustion engine, journal friction, kinetic energy, link motion, live center, live load, live steam, low frequency, magnetic field, macadam road.

15. mean effective pressure, mutual inductance, narrow-gage railway, normal consistency, overshot wheel, pathogenic bacteria, power factor, prime mover, public utility, raw materials, reciprocating engine, residual magnetism, rod intercept, ruling grade, saturated steam, septic tank, shearing strength, short circuit, specific heat, specific gravity.

16. structural steel, tangential distance, tangential offset, tensile strength, temperature gradient, thermal insulation, tin plate, topographic map, torsional strength, train resistance, triangulation system, ultimate strength, ultra-violet rays, velocity head, vertical shear, volatile matter, voltage drop, white heat, yield point, Young's modulus.

17. angle of entry, angle of incidence, angle of repose, axis of rotation, center of gravity, coefficient of friction, degree of curve, factor of safety, limit of motion, line of collimation, lines of force, line of sight, loss of head, maintenance of way, modulus of elasticity, moment of inertia, point of decalescence, reduction of error, right of way, run of mine.

18. in parallel, in series, a step-by-step, a hole-in-the-air, acre-foot, ampere-hours, foot-candle, foot-pound-second, horsepower-hour, miles-per-hour-per-second.

CHAPTER XV

ORAL COMPOSITION

- The Speech.
  - Content.
    - Information.
    - Interest.
  - Arrangement.
    - Organic effect.
    - Cumulative effect.
- The Speaker.
  - Appearance.
    - Presence.
    - Bearing.
  - Expression.
    - Voice.
    - Language.

This assignment contemplates oral exercises reproducing the substance of full-length articles on subjects lying within the field of engineering. In this part of our work we are focusing upon delivery; accordingly, we get the material as easily as possible. By taking articles written by experts on subjects regarding which they have had particularly favorable opportunities for gathering first-hand information, a degree of interest is obtained that could not otherwise be counted on. Much, again, may be learned regarding the manner in which such trained minds present the subjects which most closely concern them. Incidentally, the student, in his search for articles for oral presentation, increases his acquaintance with the periodical literature of engineering, and learns something of the general character of the different journals, and of the special character and quality of their articles. He develops his critical faculties in the selecting of his own articles on which to report; and also finds

here an opportunity to compare real professional work—its substance, organization, and import—with the amateur work which grew out of the earlier exercises in the book.

While one student is reporting, the others listen with a view to discussing the topic as presented, to preparing for their notebooks a brief comment on each report, and to gathering from some one of the three or four reports that occupy the hour material for one more critical review to be written up outside of class.

These exercises looking to the development of critical judgment and powers of expression, are supplemented by analytical work and work in memory training. After finding an article *lying within the scope of the assignment* that to him appears both interesting and important, the student examines it to see if it be well organized. If it is, he makes from it a full outline of three or four manuscript pages, following the order as he finds it, and adding nothing save possibly a statement at the close of the introduction of the divisions under which he plans to present his material. After framing this outline, he studies the general sequence of its ideas, and familiarizes himself with the direction taken by the thought in the filling out of each main head. This done, he jots down these heads on one or more 3 by 5-inch cards, and adds to them any statistical data, formulas, or similar factual matter that he might not reasonably be expected to commit to memory. Now all that remains is that he memorize this card outline, and learn to catch from its few heads suggestions of the larger outline, and so of the full body of material from which this was drawn. At this point he is assured of something worth-while to talk about; and what is more, of a command of this material in what we may call a professional arrangement. An assumption, during this particular exercise, that the speaker is the original author; that he is an authority in that of which he speaks; and, conversely, an abstaining from all references to "the article" or to "the writer," will add materially to the reality and consequent effectiveness of the whole presentation.

ARRANGEMENT OF THE SPEECH

We come now to the arrangement of our talk. It will consist, structurally, of course, of a body set off at beginning and end by an introduction and conclusion. The business of the introduction is to bring to a focus the minds of the hearers, that but a moment before have been occupied with a great diversity of topics. Again, it is, as Cicero puts it, "*reddere auditores attentos, benevolos, dociles*"—to gain the attention of the hearers, to win their favor, to bring them to the point where they are ready not only to listen but to learn. Almost without exception, audiences are friendly, glad to be talked to, curious, eager to learn. The speaker who gives evidence of a command of his subject, who shows careful preparation, who adopts a friendly conversational manner, and who is reasonably free from personal eccentricities and idiosyncrasies will almost inevitably meet with a favorable reception.

Among the specific points for him to bear in mind are the following: The obligation of acknowledging both the one who introduces him and the audience; the advantage of prefacing his most carefully considered introductory remarks by an allusion to some previous speaker; or to some current topic, or known interest of those present; the desirability of referring by way of comment or modification to his own topic as announced. Under no conditions is apology likely to be effective. To come full of the subject, and to have the subject headings well coordinated are the surest safeguards against stage fright. The opening remarks may profitably be followed by any outline of facts that will tend to place the topic in proper perspective, historial or otherwise. Next, some term or some larger aspect of the subject may call for definition; some divergencies of opinion either public or professional may seem to demand a word of comment; after which comes the partitioning, that is, the dividing of the body of discussion to be entered upon into its main heads. Shafts of light, so to speak, should be thrown down the paths about to be followed. The scope of the talk should be indicated by a few, definite, related, and

climactically arranged topics—topics that recommend themselves by their perspicuity and utter naturalness. We promise order in place of chaos; in place of vagueness, the light of mind.

This brings us to the body. Here our first work is to interest, for mere information fails of its own end. Only where emotional reaction is present shall we find assimilation. To be interesting, a speaker must give the effect of thinking as he goes, of thinking aloud. We want no set speech, no declamation, no canned excellence,—nothing "out of the barrel,"—nothing long "in the wood." Facts must be definite; anecdotes and applications—something to "illustrate" what is said must be frequently introduced. We must be made to feel that despite its difficulty (and some technical subjects are, indeed, quite too hard for effective oral presentation) we are following a trend of thought, and following it to good purpose.

As regards instruction, we can say that of all flat tires the worst is a speech only half inflated with information. Maximum effectiveness implies the dissemination of the largest possible amount of information per head of audience. Confusion, jumble, scrappiness, fragmentariness are all anathema. We want composition worthy of the name,—unity, continuity and coherence, a constant augmenting of significance. We want no aimless groping, no blundering here and there. Let the heads be few: two subheads in the introduction, two subheads in each of the two parts of the body, one telling point in the conclusion—seven in all, a perfect number. Then let the whole be organic, vertebrate, articulate. All important are the transitions. Let the speaker, as he proceeds, pause at transition points to note accomplishment and to mark the direction of further progress, again lighting the way ahead by shafts that show the course but not the details. By such orderly release of his material, by these background glances and glances of anticipation, by going slow at the turns and stopping at junctions for passengers, the speaker will do his part in insuring the proper transfer of his material. Let him tell what he will say; say when he is telling it; and tell again what he has said. No less factor of safety will suffice in oral composition.

Incidentally the speaker should give particular attention to that danger spot, the third quarter of his talk, lest there his ideas become confused, and lest the interest of his audience begin to lag. He should be careful to slow down his progress when dealing with statistics or with any other such raw stuff of fact. He should watch his audience throughout, and gage his effort by indications of their comprehension and enjoyment; and often he should ask, "Am I telling this so that they will know it tomorrow; so that they will remember and refer to it next week—next year?"

Our audience should be brought into the field by easy stages. Electricity may be discussed from the point of view of its transmission or of its utilization in industry; its uses are mainly for light and power; in the latter field it serves the purposes of traction and of production. And so we lead on to the subject of electrical power machinery in factories. And through the course of the discussion our audience has gradually been enlightened, and more than that has been filled with that knowledge which proverbially is power. Gradually it has become aware that the end of the discussion is approaching; and then, that this promise of good terminal facilities is not belied.

Still, one word is needed,—"the last and the best,"—the conclusion. This must be a separate entity, no running over of material from the body, no ineffective afterthought, no merely formal gesture of finality. It must be strong, significant, sincere in its expression; it must give point and pertinency to whatever has preceded. This is the speaker's opportunity to clinch what he has said, to point out its larger import and alliances, to show it in close association to those facts he deems most salient and rememberable. Then remains one "telling" final sentence, the "Thank you," if this be used, and a dignified departure from the platform.

We have spoken of the card outline. The use of this card presents a number of important points of technique. In the first place, the audience should feel in it an unobtrusive presence, not its own rival for the speaker's attention. Never should it be read from or talked to; nowhere during either the introduction or the conclusion should it be referred to at all. In short it is a wand and not a crutch;

it is not a thing to fuss with, but a bit of stage property to occupy the hand, and to serve to point with or to emphasize a gesture. Rightly used, it tends to put the audience at their ease in the matter of the speaker's remembering his speech; it vouches for his previous preparation, and for the accuracy of his statistical detail. After the possible manuscript, it will in any case prove a welcome relief. Chiefly it will be glanced at in the rhetorical pauses between sections; and in this glance the hand will raise it to the eyes—not so as to hide the face. Never will it be laid on the desk and bowed to in the act of reading. Properly used, the card or cards—but not the debater's full deck of cards—does much to accredit the speaker and to enhance the effectiveness of his presentation.

Among other attention catchers and attention winners we might note the following: Let the speaker set forth the subject as a thing recognizable, as a matter of present interest and of no inconsiderable concern; then too, let him manifest a personal interest, even enthusiasm, in it himself, and what is even more important, an interest in the audience and in their coming to share his own enthusiasm. His will constantly be the "you attitude" or the "we attitude." "You might wonder how . . .," he will begin some passage; and "Suppose we take . . .," or "Now let us look into this a moment . . .," he will continue. A responsive attitude towards the audience will breed responsiveness in them; a quickness to take advantage of unforeseen interruptions will win them to him; a touch of humor, or an occasional anecdote will strengthen this approval. A nice tension between an attitude of deference and one of considerable familiarity—between "Mr. Chairman, and gentlemen" on the one hand and some such colloquialism as "so along about two o'clock in comes . . ." on the other, is perhaps ideal. Pleasantry the audience will welcome, but never impoliteness. Any and all remarks from the platform to another person should be formal and gracious. "May we have the last picture again, please," is a far better request to make of the assistant at the lantern than is "Gim'me that last one again." And by such means as this the speaker will strive to win and hold his audience; to make his own interests contagious; and to

approve himself to them through his ability to hold well in hand the entire situation—himself, his material, his auditors.

Nothing that the author does so holds the attention of his hearers—or better here, his see-ers—as does his use of the material of illustration. Maps, charts, sketches, graphs, diagrams, photographs, tables, figures, formulas—we like them all. And no less are they interesting than informationally important. An article on the Roosevelt Dam, or the Wilson Dam, or the Coolidge Dam, without map or diagram were no article at all. And once more, either maps or structural figures with no indication of distances or dimensions are but tantalizing and incomplete. In certain cases a "close up" supplementing a more comprehensive illustration promotes better comprehension. Especially do we enjoy seeing specimens and samples in the round, either exhibits previously provided or illustrations called to mind extemporarily, as when a speaker on modern glass found twenty unsuspected sorts about the room. Articles passed around the room, because of their turning attention away from the platform, are of doubtful advantage. A good blackboard drawing, especially when it is progressively elaborated with something of the chalk-talk effect, is infinitely superior to pale lantern pictures or invisible photographs. Sketching involves intelligence, judgment, skill, action, the last especially lying at the very root of any dramatic presentation. But besides sketches, board work involves the setting before the eyes—the "Presenting to sense," to use Professor Laurie's favorite expression—of words and numerical figures. Thus at the start the title may well be written out—centered and high up out of the way—if it contain any word that might by any chance mislead the ear as to its identity. As examples we might take

The Tanktread Sand Loader
The Sado Gold Mine
The Rainey Oil Mining Process.

So, also, casual words of unfamiliar aspect such as *insulite, zonalite, furfural,* may well be jotted casually on the board. Statistics and numerical formulas, whether chemical or

mathematical or otherwise, should invariably be placed upon the board; and whatever relations suggest a table or a plotted curve should also be so presented. If they be too complicated for convenient writing down during the progress of the talk, they may be put into exhibit shape beforehand either on the board, or on a large sheet of paper. In arranging tables use judgment in deciding what should go in the horizontal columns and what in the vertical; see that all lists are arranged according to some principle; wherever possible, pair or group or regularly graduate the items. See that no confusion enters as the result of failure to reduce coordinate items to the same unit.

Among specific suggestions bearing on the technique of board work, the following come to mind: Write well up on the board, beginning on the left side and working continuously toward the right. Plan the arrangement in the space available; work for economy combined with maximum informativeness; so far as possible leave until the end all that has been put on the board. If the board must be erased, do it thoroughly and completely at the start (using here and for all erasures, an *eraser* rather than the hand): Make all figures and legends large enough to be readily seen by a person with reasonably good eyesight anywhere in the room. Draw clear sharp lines, make figures neatly, and write or print in a legible hand. Write words indicating the identity of parts outside of the drawing and so far as possible in a horizontal position, carrying in arrows, straight-lined, to the parts represented. If, occasionally, colored crayon will help, use it.

While drawing, do not try to put on too much at once; do not attempt to draw and talk at the same time. Strive to keep the body so far as possible outside the line of sight of the audience; when writing low on the board, lean over, don't scrootch. In resuming the talk, step to one side—outside—the work on the board, and in referring to it use the hand on that side, indicating exactly the point to which you desire attention to be directed.

While these are by no means the only matters bearing on this technique, they do, perhaps, call attention to the fact of a better and a worse way of performing even seemingly

insignificant things; and in so doing they may stimulate the student to that attitude of critical attention which precedes mastery.

The Speaker

No river can rise higher than its source; no composition can rise higher than the mind that created it. Every speaker should accredit himself by his appearance and by his expression; through the idea which we get of him from sources other than his words and attitude,—through the idea which he conveys to us by his language and by the quality of his sentiments.

We instantly "size up" a speaker upon his first appearance. Invariably we judge the man before the message; and he, whether he will or not, abides our decision. Accordingly, the speaker should bear in mind the critical importance of this first impression, and consider also the "points" by which audiences are wont to judge. As he appears, do they get a sense of cleanliness and neatness? Or, do they see his collar soiled; his coat wrongly buttoned, and his tie askew? Their impression in the two cases is not the same. Has he evident self-respect, then they respect him; has he regard for himself, then they reciprocate that regard. Again, the mental attitude of the man is contagious, and moreover, a factor not without its influence on the amount of information communicated to the audience. Is the speaker slow, sleepy, tired, indolent, sluggish, listless, lackadaisical, nerveless, one who seemingly doesn't care whether school keeps or not?—then the audience does not warm up to him. Is he, once more, stiff, rigid, inflexible, over formal and correct, or perhaps constrained, flustered, ill at ease?—then we are not able, what for thinking of his discomfort, to put any considerable part of our attention on what he says. Has he, on the other hand, poise? is he confident, deliberate, cool and collected, quite at his ease before us?—then he makes us too feel at home, and we accept him gladly as a competent and dependable guide through whatever course of thought may lie ahead. The man, like every perfect medium of communication, fades out of our impression and only his ideas remain. Has our speaker, finally, that forceful and

dynamic quality of the born leader? is he a man not only alert, but mentally stimulating? a man not only of "quick and flexible intelligence," but of moral force?—then we recognize the vivifying power of personality, the hall-mark of genius, and we give ourselves into his direction heart and soul. His ideas we unconsciously assimilate; his followers and his champions we become. Our reaction to men, in short, is largely a reaction to temperament. The phlegmatic we disregard; the sanguine we love and fraternize with, but do not follow; the melancholy, or thoughtful, we trust; the choleric,—those masterful spirits, we gladly follow and obey. Whenever a leader speaks, his very attitude bids us listen; and listen and attend we do.

But the first impression soon becomes a cumulative impression. Besides the "presence" of a speaker, we feel his bearing; this finds expression in posture and movements. Is he self-sustaining? Does he stand erect on both feet, and resist every temptation to looseness and leaning? Does he stand facing his audience while speaking, and approach them as closely as circumstances permit? Do we get the suggestion of a general harmoniousness in the man and all he is and says; a suggestion of control and definitiveness, of a slight tension perhaps, as though the speaker were doing his best for himself and for us? Is he making everything contribute to the getting of his message across in an adequate and workmanlike manner?

Movements of course are most important. Effective presentation is always to a certain extent dramatic, and the beginning and end of drama is action. We are all familiar with the ineffective speaker who is given to meaningless shufflings and fidgetings about, to weavings to and fro, and wrigglings about; with the speaker whose hand is preoccupied with the change in his pocket, or with a fussy pecking at some button on his coat, or with the twisting of a piece of chalk or a pencil. We are likewise familiar with the stark immobile ventriloquistic figure that stands rigidly before us and recites a set speech laboriously learned. To both of these, and no less to the barnstormer whose "working all the time" is rather physical than mental, we prefer the person whose movements are quiet but significant, who

turns frequently to the board and easily turns back again, whose slight shifting of position helps to mark a transition, whose every gesture is emphatic, and whose slightest glance is accompanied by an answering movement in the eyes of the audience.

No gestures are quite like eye gestures. The man who reads or talks over his shoulder to the blackboard can never control the eyes, and through them the minds of his auditors. The effective speaker does not look over their heads, but into their faces. He does not count the electric light bulbs, or scan the roofs across the street, or stand with vacant stare, his empty eyes focused on nothingness. We want the eye-hold on the audience—eyes that look now at this one now at that; eyes that look into many specific faces in the center, to right and to left, at different distances; eyes that talk to individuals, not to the mass.

Expression in Voice and Language

"Speak, that I may see thee." What does this imply? That personality is revealed through verbal or vocal utterance. One may be recommended not only by what one says, but by the quality of the tones and inflections with which one says it. Speech should be informative. True. Likewise it should be clear and pleasant and direct.

First of all, one should be audible. That a speech be given is of less moment than that it should be heard and understood. Consequently, the speaker should assure himself that his voice carries to every part of the room in which he speaks. To this end he should speak deliberately, neither haltingly nor monotonously. He should speak with distinct articulation and enunciation, attending to the pronunciation of all final letters, and of all expressions made up largely of vowels and liquids. We don't want to hear "I tol jer" or "Yer take yer"; we do not want to hear every syllable of, "these lightning arrestor grounds," and of "now a new era dawned in the ore industry." Attention should further be given to the inflection of sentences, to all that vocal punctuation, so suggestive of transitions, italics, colons, dashes, parentheses, and what not—the very marks of punctuation

owing their origin to the Greek desire to mark the ideal four-fold movement of a perfectly balanced sentence:

the entire sentence or "period" (περί+ὁδὸς; "path around" the idea) having its "limb" or "colon" (Latin, *membrum*) on either side, each limb, just as at knee or elbow, being "cut" by a "comma." But all our punctuation is at best a make-shift. The real "stops" or voice signals, now quantitative, now qualitative, apprise the hearers of many a turn of thought that in writing passes perforce unmarked.

A pleasant utterance is a most ingratiating thing. How far superior to flatness or singsong or to a high-pitched recitative voice is a voice natural and conversational, pure in tonal quality and well modulated in rhythmic character. The "E-r-r"-ites and "And-er-r"-ites we utterly abjure; all harsh cacophonous raspiness is anathema to us.

But finally, we demand of the speaker that he not only interest and inform, but also impress. To produce belief one must be incisive. In one place he must have command of "short, sharp, dazzling, burning sentences," in another he must pause to allow his message to etch itself into the mind. Vehemence requires one technique, reasoning another; the rate that best serves easy narrative will never do for matter that must be considered carefully and noted down. At the start a speaker should give the impression of surety and confidence and command of his subject; and his later performance should not belie that impression. The way to make others believe he knows his stuff is—to know it. "Knowledge is power," but knowledge in itself is not enough. The speaker must have the art to "put the thing across"—to build up interest and stimulate curiosity; to fix things memorably in the mind; to recommend his opinions and beliefs to the minds of those who hear. Clear at the start, he must be definitive at the end; he must guard against any mumbling of last words, any trailing off into indistinctness. The last word must be the best, must cap the climax, must crown with finality something well begun. Elocution is the bow that drives the shaft of logic home.

As a final element in oral composition, we mention lan-

guage, the actual words singly and in combination. These first by themselves and then in their arrangements must be correctly used and effectively used. In the first instance we judge of sufficiency by the criteria of lexicography and of grammar, in the second by those of rhythm and of rhetoric.

To make mistakes in the form of language generally lays one open to the charge of illiteracy. We place immediately anyone who says *clumb, attackted, overflown* for *overflowed, gotten, preventative, ingrediences,* etc. We form a rather definite opinion of the person who says *crick, rē'-search, fi'-nance, dăta, dē'-fects,* and *maintain'-ance.* We find it difficult to admire, as perhaps we should like to, the speaker who quite unconsciously makes use of any such expressions as the following:

1. This don't take very long.
   It overflowed bad.
   The driver sets on the floor.
   The well is fifteen foot deep.
   We had to leave them set.
2. This here consists of fine aggregate.
   They only have one boiler.
   These piling were driven in three days.
   The sulfur is overlain by earth.
   There is no danger of it burning.
3. They claim this is sufficient.
   This here dam is quite simple.
   The maximum of bricks were laid.
   This feature is rather unique.
   I propose to show where this loss comes in.
4. This pump has proven to be a success.
   There isn't any spikes in the front wheel.
   This didn't work like it really can.
   This was a success from the start.
   Now this here filter is a great improvement.
5. I and several other fellows saw the accident.
   An operator making a mistake is costly.
   This is the best laying land in Utah.
   Blue lead can be painted like ordinary paint.
   It promises to be a very cheap dam.
6. As to the weight, they vary considerable.
   I would like to bring out two points.
   This system it purifies the water.
   I have only drew the outline.
   A new level would not be practical.
7. The origin of Portland cement comes from England.
   It travels slower than the other boat.
   There is no available data on this point.

A great deal of our boilers are out of date.
These piers are only sunk four feet.
8. This was the only provision that was provided.
It seems now like it won't be long.
With a booster you could have a steeper grade.
As the water raised, sandbags were added.
The weight was around five hundred pounds.
9. When anyone applies they are inspected.
As to its strength, it is very strong.
This has the largest capacity of any plan in the world.
It is very necessary to understand the process.
Now this is where the air comes in at.
10. This did not happen near as often as before.
Each of these are to be built as separate units.
The Yukon has the worst ice conditions of any river.
This implies a certain amount of hydrogen atoms.
Pressed steel will never substitute forging completely.
11. Now this is the right kind of an oil for winter.
Another danger due to concrete is laitance.
This process consists of two main points.
We are very interested at present in radio.
What do you say we show this in a graph?
12. This explosion came as a sort of a surprise.
As a result they had to look someplace else.
The relative merits of these differ considerable.
This is hard on the existing roads of the present day.
In my talk I wish to talk about the uses of granite.
13. This sort of a road is hard on motor cars.
So the tools have to return back to the sharpener.
Other types of finish are varnish and shellac finish.
There was a good many cracks in this casting.
I will attempt to draw a diagram of the layout.
14. Thus they have little incentiveness to good work.
The means how this should be accomplished is simple.
This plan is somewhat different than anything tried before.
And the same way is true when the dynamo acts as a motor.
So what they did, they built up a caisson and went on as before.
15. Now the uses of this instrument; it is used mostly for measuring.
The crane had gotten loose and proven dangerous.
This material is very insulating to sound and fire both.
This company puts out a product cheaper than other places.
We lay out the line down through the center of the road.

Such are some of the problems of oral composition; and such are some of the factors entering into the solution of these problems. The more rules obeyed, the more effective the expression; and in speech we must add much to the technique of writing. He who can supplement a mastery of the one by a mastery of the other, will utter winged words, and put compulsion behind his shafts of thought.

CHAPTER XVI

THE NEW-INVENTION TALK[1]

Viewpoints of presentation.
- Of earlier apparatus paper.
- Of this present discussion.

The main divisions of the presentation.
- Of the introduction.
  - Definition.
  - Division.
- Of the body.
  - Features.
  - Adaptability.
- Of the conclusion.
  - Summary.
  - Evaluation.

Accessories to the presentation.
- Pictorial.
- Personal.

Already we have considered a paper dealing with the description of apparatus; but whereas in that case we restricted our attention to mechanical matters, in the present exercise we shall find occasion to treat our subject from other viewpoints, including more particularly its advantages, economic as well as technical.

The Main Divisions of the Presentation

Our introduction may here, as before, begin with some comment on the timeliness of the subject, and then go on with definition and history. As quickly as possible we desire to get the subject into the minds of our auditors—sharply focused and truly proportioned. We want them to know

[1] For suggestions regarding the conducting of such oral recitations, see pp. viii–ix, 200–201.

its place in the world of affairs—to know who uses it, and for what purposes. Interesting, also, are the name of its inventor; the circumstances of its invention; the place of its manufacture; the patents under which it is produced. Quite possibly this preliminary presentation will be furnished by some reference to related contrivances with which this one can to advantage be compared or contrasted. Then, closing the introduction, comes the "division" with its formal listing of the heads of the article—including structural features, or structure and operation, or advantages and peculiar adaptability. These points in their more salient features will once more be referred to in the conclusion; but here they find their first explicit mention preliminary to their full development in the body of the discussion.

The body, as we have said, sets forth in some fullness of detail the distinguishing features of the thing discussed, together with the points that recommend it to favorable consideration. The first head may include both a general and a detailed description, along with some account of control or operation and, it may be also, of the principle underlying the operation. Supplementing these may come notes on the specifications under which the contrivance is manufactured, or other notes bearing on anything of interest connected with its production. The entire purpose in this section is to make the thing stand out as a definite entity—in its shape and its size, in its materials and its construction; to familiarize the hearers with its manner of performance, with its mechanical relationships to other apparatus, and with the distinctive points of its differentiation from them.

The second head may take up the advantages, the "talking points," of this contrivance,—its strength or lightness, its compactness or durability; its elimination of old difficulties, and its embodying of new improvements; its simplicity, and convenience, adaptability, and great range of capacity. Any standardizing of its features which would recommend its adoption, anything about it that would effect a saving of time or materials, or of labor costs, or of replacement expenses, may here be mentioned. Naturally, also, the tests that it has met in laboratory or in practice are peculiarly pertinent to this part of the discussion.

The business of the conclusion is to emphasize the salient points of the thing discussed—to call once more to mind its specific advantages, both mechanical and economic; to point out its prospective field, and its immediate promise of wide adoption.

ACCESSORIES TO THE PRESENTATION

Almost certainly this presentation requires illustration—the prepared sketch, the free-hand drawing, the lantern,—best of all, the object itself; one or another of these should regularly be utilized to present the thing to sense. In his use of such illustrations, the speaker should remember that a definite pointing out of any part referred to is infinitely more effective than is any distant mention of it as being represented "over there in the picture."

Clearness, coherence, interest, information, explicitness in preliminary announcements, conscientiousness in the fulfilling of every promise of development—when to these are added a pleasing presence and distinct elocution, the talk is likely to be remembered well beyond the time of its delivery.

In view of the rapidity of progress in mechanical invention, the suggestion of subjects for this exercise is particularly difficult. By day after tomorrow, at least, the wonder of today will be an old, old story. Yet tomorrow and the day after will have their new pipe joints and improved vacuum tubes; they will have their own vitaphone and television, their balloon tires and four-wheeled brakes; their rotor boats and locomotive boosters, their Liberty motors and new propellers. Any of these will provide topics both of interest and significance for such an exercise as this.

CHAPTER XVII

THE INVESTIGATIVE PAPER

- Some problems of composition.
  - Procedure in taking notes.
    - The problem of facts.
      - Their sources.
        - Survey.
        - Scrutiny.
      - Their evaluation.
        - Authority.
        - Originality.
    - The problem of form.
      - The writing of notes.
        - Materials.
        - Arrangement.
      - The accrediting of note material.
        - Primary references.
        - Secondary references.
  - Procedure in working up notes.
    - The tentative outline.
    - The gradually evolved organic plan.
- Some types of investigative paper.
  - The materials article.
  - The properties article.
  - The analytical article.
  - The general article.

Some Problems of Composition

Most articles prepared for publication depend chiefly on personal experience; but this experience is often supplemented by reading and investigation. Before we write we should be reasonably familiar with all the available literature of our subject. This usually implies the taking of notes.

The first essential of notetaking is that the investigator have some definite ideas regarding how to go about it—regarding the possible sources of information and the proper appraising of the data that he will meet with, once these have been uncovered. Among the general sources with which the student should be familiar might be listed the several encyclopaedias, the handbooks of the various branches of engineering, textbooks covering more comprehensively the same subjects, and for miscellaneous book references, the card catalogues of local libraries, and of the Library of Congress. He should know also the *Statesman's Year Book*, the *World Almanac*, and the volumes of abstracts comprehending the publications in the several branches of science both pure and applied. He should in every case avail himself of the resources put at his disposal by the various tabulations of the vast field of current periodical literature, such as *Poole's Index*, the *United States Catalogue* with *Cumulative Book Index*, the *Reader's Guide*, the *Industrial Arts Index*, the *Engineering Index*, and the indexes to the several Proceedings, Transactions, Journals, Quarterlies, and Bulletins of the national engineering societies and institutes. By looking up in these sources the terms relating to his subject, the investigator makes a start; and as he reads on, he adds new items to his bibliography, both from lists and from casual references.

Unquestionably one must learn how to read; for reading implies much more than an ability to pronounce the words on the printed page. In one case, ability to read means skimming through a book—getting a bird's-eye view of it; again, it means considering a passage sentence by sentence, as a succession of propositions—as a continuous tissue of interrelated fact. In general, the trained reader will look first to books of a comprehensive nature that he may get his bearings in the subject, note its extent, its ramifications and relationships, and so acquaint himself with the amount of work ahead of him and with the direction in which his progress most profitably might seem to lie. After this he can concentrate to better purpose on particular aspects of the subject, upon books and articles that have promised most.

When taking up any book, the reader does well first to leaf it through rapidly, glancing at the preface and table of contents, noting the presence or absence of an index, of headings of the various sorts, and of transitional and summarizing devices—all this to the end that he may see how much of it is new, and how much is occupied with ground already covered; that he may determine to what extent he should go over this new material, and with what degree of ease or difficulty this can be done. The mental attitude of the reader is most important. He should be deliberate and unhurried, without losing any time; he should be keen, alert, attentive, curious, observant, anticipative, without lapsing into habits of sketchiness and superficiality. Constantly his mind should play about the subject, seeking both inner and outer relationships, questioning, criticizing, appraising—as Bacon counsels, weighing and considering as it goes. To attempt this sort of reading consciously at the start is in time to develop habits of inestimable worth.

The importance of judgment in notetaking is a matter that cannot be overstressed. Success in every case lies in selection rather than in collection. The first defense against a futile self-defeating all-inclusiveness is an idea of the direction from the center in which the final limitation of the subject is likely to be found, and a using of this knowledge as a touchstone for the testing of potential notes met along the way. A too narrow restriction at the start and a too-long-delayed determination of the exact scope of the prospective article are alike unfortunate. Having these points in mind, the reader further discriminates as he proceeds between an author's opinion and his experimental conclusions; between mere factual assertion and statements that are supported by ample evidence; between authors and authors, and articles and articles; and, finally, between matter of immediate intrinsic value and pertinency and matter which possesses merely a specious and incidental interest. Naturally much that is taken down will be condensed to whatever expression may be judged most compact and economical. Recording, as in a memorandum, the gist, the kernel, the substance of a bit of information is what is important, not any transcribing promiscuously of pages and

pages all quite unassimilated. Nevertheless, when real doubt exists regarding the inclusion of an item in the notes, the reader does well to take it down while it is right at hand, rather than risk the necessity of having to search it out at some later time.

Immediately one begins to put notes on paper, questions of form arise. These involve not only the matters of phraseology and identification, but also that of notetaking materials themselves. One needs a good pen, not too coarse, or several medium-hard pencils, well sharpened; and besides these writing implements, one needs cards or sheets of paper. The most usual sizes of card are 3 by 5 in. and 4 by 6 in. The former are especially well adapted for permanent references from books and articles, for mounted clippings, and for occasional data to be permanently filed. When used for notes, the card may well contain at the top an index word; below this, a topic suggestive of the aspect of the subject thereon treated; below this again, some single group of closely related details either factual or suggestive; and lastly, a full and exact reference to the place where these data are found.

But for many forms of notetaking, loose sheets of paper 8½ by 11 in. are best adapted. In using them one cuts the paper to the note; not the note to the paper. They have the advantage of permitting a spreading out of material through several degrees of indention, and the inclusion of more matter than can be conveniently gathered upon a single card. But here as before each topic should be placed by itself and referenced; then the sheet is divided and the notes distributed under the headings of the article. If these headings are numbered in the outline, then the slips can be numbered as they are sorted. When a note sheet is thus to be cut up, the writing must of course be confined to one side. Just as a filing cabinet serves best for the preservation of notes on cards, so manila envelopes of 4 by 9½ in. or thereabouts, properly inscribed, prove most satisfactory for preserving these notes on slips. That the investigator should preserve them with all the rest of his working material has been abundantly proved in that sad, sad school kept by experience.

In the putting down of notes from reading, a sharp differentiation should be made between (1) direct quotations—these to be copied *literatim* and checked and rechecked for wording, capitalization, and punctuation; to be written, once more, with three dots in the place of any words omitted, or four dots where a sentence end is included in the break; and invariably to be included within quotation marks; and (2) abstractings, summaries, or paraphrases of an author's work; and (3) one's own original comment and observation prompted by the reading—which should be *marked* as original, possibly by including it within brackets.

Few things prove more exasperating to the taker of notes than the appearance later of some orphaned item, of positive value but useless to him because of the absence of reference to its source. To obviate this provocation, the reader should—let us repeat—attach to each excerpt and to each abridgment a notation of its place sufficiently detailed to enable another person to turn to the original with a minimum of inconvenience. Although usage is not fixed regarding the form to be given such references, the following arrangement may be adopted with perhaps as much assurance as any other.

The first reference to a book should include these data arranged in the order listed:

The author (or **authors**)

Surname, followed by a comma.

Christian name or initials, as these appear in the title page. Usage in formal alphabetized bibliography. Frequently in footnotes the Christian name or initials precede the surname.

Where an editor is to be distinguished from an author, the name is followed by the abbreviation "ed." either set off by a comma or parenthesized.

In casual references this item is followed by a comma, more rarely by a colon. The most conservative formal punctuation is a period.

The Work

Chapter Title, where this is to appear, inclosed within quotation marks, and followed in casual references by a comma; in formal, by a period. Capitalization may be restricted to the first word and proper nouns and adjectives.

Name of book, italicized (in manuscript once underscored), and followed

by a period (rarely, by a comma). Or by a comma if it is succeeded by a special item.

Special item, regarding any series to which the volume may belong; the number or name of its edition, e.g., "3rd ed."; or, "edited by . . . ."; or, the number of volumes, e.g., "5 vols." This item is followed by a period (rarely, by a comma).

The Imprint

Name of publisher, as this appears on the title page, followed by a comma.

Place, usually city, of publication, followed by a comma.

Year of publication, accompanied possibly by a parenthesized note regarding other editions, followed by a period (rarely, by a comma). Variants of the full imprint are the following: "1912."; "London, 1912."; and, especially when no references follow, "New York: John Wiley & Sons, 1922." Followed by a period; or, in quite informal references, by a comma.

The Reference

Volume, where more than one occurs, indicated by a roman capital, sometimes standing alone; preceded usually by "Vol." (if a period closes the imprint), or, if a comma closes the imprint, by "vol."; and followed by a comma. Chapters are distinguished from volumes by being numbered in roman lower-case letters.

Page (or section), sometimes with the abbreviations, p., pp., ff., *et. seq.* (*et sequentes,* "and the following"), or *passim* ("here and there, all about")—for example: "p. 167"; "pp. 167–169"; "167 ff."; "220 ff., especially 223, 225"; "p. 225, especially ll. 10–15 and note 1." This item closes with a period; standing alone, it is capitalized.

Possible comment bearing on some special feature, or on the general value of the book.

The first reference to a periodical should include the following items:

The author (or authors)

Surname, as before.

Christian name or initials, as before.

The Article

Title, inclosed by quotation marks, and followed in casual references by a comma, but in formal bibliography by a period. Capitalization may be restricted to the first word and proper nouns and adjectives.

The Publication

Name of the magazine, bulletin, journal, etc., once underscored in manuscript for italics, and followed by period (or a comma) as in the case of a book name.

The Reference

Volume of the publication, followed by a comma. Note that the abbreviation for "volume" is sometimes omitted. Where this item follows a period, this abbreviation should be capitalized.

Number of the issue, where this should be included, followed by a comma when the following date is not parenthesized; or, where it is, by no punctuation.

Date of issue—to facilitate the finding of the volume and number—consisting of the year, the year and month, or the year month and day; thus "Vol. IX (1912), pp. 207–213"; or, "Vol. IX, No. 5 (June, 1912), pp. 207 ff."; or "Vol. IX, June 5, 1922, p. 222, note 2."

The Page, or pages, sometimes the abbreviation for "page" and "pages," etc., are omitted as in the following: "Engineering Review, XX (1912), 122–127." The second of two inclusive page numbers is written out ("122–127"), whereas with dates the second is abridged ("1924–27").

In the manuscript, footnotes are numbered throughout each chapter and placed between straight lines across the page, to be moved down to the bottom of the page afterwards by the printer.

In later citations of a work, numerous reductions are permissible. The surname may stand alone; the work may be referred to by its first outstanding word; or, reference may be made to it, where no other citations intervene, by the Latin abbreviation *ibid.* (*ibidem,* "in the same place"); or, where other citations do intervene, by the author's surname followed by *op. cit.* (*opere citato,* "in the work cited"). Corresponding reference to a periodical article or to some other publication of composite authorship is made by the use of *loc. cit.* (*loco citato,* "in the place cited").[1]

Procedure in Working Up Notes

The wise investigator starts with a fairly definite idea of his subject and works along "to see what comes of it." Gradually amid the chaos an outline begins to suggest itself, and thereafter the subject like any other organism "shapes itself out." "If a man can group his ideas," says Stevenson, "he is a good writer." [2]

[1] See "Footnotes," *Dissertations in History and English.* University of Iowa *Service Bulletin.* Vol. V, No. 30 (July 23, 1921), pp. 4–5.

[2] Rickard, T. A., *Technical Writing.* John Wiley & Sons, Inc., New York, 1920. P. 169.

A prominent engineer, referring to some writing he was doing, said, "I have it nearly done—I have it outlined." Outside of the writer, is chaos and confusion; within, is —or should be—order. The thought process occupies itself mainly with making and matching, logically, valid combinations; with bringing together ideas of the same order on several levels of importance, and thus shaping by successive steps an organic whole with whose sufficiency the mind is satisfied. By slow stages of elimination, combination, and amplification, amid the chaos and turbidity he finds the final form. Line by line, its symmetries appear; its articulations become evident; each several surface rounds itself out. A little wise assistance coaxes it into some simple, well-proportioned, equilibrial arrangement, and ensures the proper homogeneity, coordination, and progress. Naturally, the longer the article can be left in a state of plasticity, gradually to settle its own problem of form, the better in the end will be the effect. From the finished outline to the full-length paper is in the first stage but a step; but, if style be considered, from the first full draft to the last revision may still be a long journey occupied by readings and re-writings, by re-readings and re-writings again.

Some Types of Investigative Paper

The Materials Article

The first thing to realize regarding this subject is that the topic should be limited, for in all probability the author's assignment is not to produce an encyclopaedic article. More likely than not he intends to write on the characteristics of the material, or on the uses to which it is put. Or, he may plan to discuss the tests by which these properties are determined, or to discourse on the principles underlying these tests. In any case, after the first comprehensive survey of the field, his immediate problem is to decide on some definite scope to be observed, whether this is to be large or small. To a certain extent this limitation will be determined by the occasion, the prospective audience, and by the assigned limits of time or space. This means that he must separate

what *must* be said from that which might well be said if circumstances permitted.

The range of subjects in this field is inexhaustible. The writer will at the start select some broad subject; such for example, as,

> **brick, cement, granite, gypsum, lime, sand, tile, veneers, waterproofing, mica, graphite, fire clay, molybdenum, mahogany, rubber, bronze, charcoal, coke, corundum, creosote, diamonds, dynamite, gasoline, manganese, nitroglycerine, platinum, terra cotta, turpentine, petroleum, sulphur, trinitrotoluene, white pine, zinc, zirconium, aggregates, alloys, fuels, explosives;**

and, strange to say, any one of these may prove more interesting than any other seemingly could become. The interest, however, is increased in proportion as his point or view is definite. To this end, the title he chooses should express his precise intentions in the article. Better than "Steel" as a subject, is "Stainless," or "Rustless steel," or even "Stainless metals" in general. Better than "Iron" is "Pig iron" or "Wrought iron" or "Cast iron"; and better than either of these is "Malleable cast iron," or "Limitations to the use of malleable cast iron." The writer can, as he chooses, treat "Concrete," "Structural concrete," "Concrete for paving," or "Concrete as a medium of artistic expression." The treatments, however, cannot be the same. Obviously, the point of view and the facts presented will both change as he shifts, let us say, from such a topic as "Asphaltic concrete," to "The properties of asphaltic concrete," or to "Physical tests of asphaltic concrete," or to "General principles governing the use of asphaltic concrete in street paving," or finally to "The relative value of various ingredients in the manufacture of asphaltic concrete."

Here the question rises as to the means by which limitations can be effected. The older, more generalized materials cause, of course, the most trouble. A relatively new one, such as Invar, Permalloy, Raybestos, Aluminate cement, or any one of the endless *-ites of* recent origin, such as Alumnite, Bakelite, Braunite, Cryolite, Ebonite, Genelite, Haydite, Lumnite, Maconite, Magnesite, Silite, Structolite, or Zonolite, is apt to be arbitrarily restricted by the limited extent of its present development; although even in this

group some substances, Bakelite, for instance, would afford a writer plenty and more to talk about. In dealing with an old material, he can restrict himself, among other ways, to the following lines of treatment, to

a classification of the members of a group:
Clay products, iron ores, nickel-chromium alloys, vitreous materials, luminous paints, slow explosives, industrial clays, automobile-engine lubricants;
a presentation limited by the nature of the ingredients:
gypsum cement, wire ropes, red-lead paint;
the place of derivation:
Ottawa sand, Indiana limestone, Iowa coal;
the process of manufacture:
fused quartz, carbonized clay, powdered coal, zinc-coated iron and steel;
the adaptability to special use:
Molding sand, woods for airplane construction, porcelain for electrical insulation;
the specific property:
physical properties of paints, some mechanical properties of wood, the magnetic properties of cobalt steel;
a combination of modifiers:
"A study of the elastic properties of small-size wire cables."

The author has the alternative of writing his title in the form illustrated by "Properties and methods of using duraluminum," or by "Helium, its production and uses." The latter amounts to a secondary title, such as we see more sharply set off in the following:

Wood alcohol: What it is and why it is deadly
Timber: Tests for its strength; its seasoning; and its production
The nature of explosives: General principles on which their composition and action depend
The properties of oils; and their relation to lubrication
Sands for glass making; with especial reference to optical glass
Stone and concrete road foundations; from the standpoint of efficiency and economy.

A secondary title might conceivably be expanded to a third title, as in the following:

"Properties and preparation of glues: Data on the properties, preparation, classification, grading and testing of glues, strength of glued joints, etc.; Based on experimental work of the Bureau of Aircraft Production."

—*Mechanical Engineering,* April, 1919, p. 382.

Quite possibly he may choose to restrict his topic in more than one way as is done in the following:

Silica sand in the manufacture of glass
Monel metal in coal-mining operations
High-chromium steel for exhaust valves
Blue lead as a rust preventive
Chinese kaolin for American potteries.

He may again elect to handle some large historical or economic aspect of his subject:

Effect of the World War on aluminum
Modern developments in the steel industry;

or he may desire to set forth some specific requirements, or the results of some specific piece of research:

Ideal boiler insulation
Standard specifications for fire brick
Some experiments on nickel steel.

In any case, after selecting his subject, he will have occasion to present the qualities of the material. After doing this he may go on to speak of their relative importance and of the efforts made to ensure their presence in this or that type of work. Thus the airplane requires metal different from that called for by the automobile; the specifications for fire brick are quite different from those for paving brick; and the filament wire of an incandescent lamp is radically different from the wire that brings the current into the house. Quite possibly the purpose of the paper will best be served by a specific comparison of the material under discussion with some other, as fused quartz with glass; Bakelite with ivory; or Flaxlinum, let us say, with Insulite. He will have occasion of course to comment on the elimination of detrimental qualities, such as acidity in oil, no less than on the development of the advantageous ones; and first and last in these subtle modifications of materials he will find a subject of perennial interest. Indeed few branches of engineering present a literature more fascinating than does that of testing materials.

The names and nature of the tests to which the material in question is subjected in order to make these determinations may also be given; likewise, the possible methods of pro-

cedure in these tests, and the relative satisfactoriness of the results; moreover, the peculiar applicability of, or limitations of, certain tests, and the general acceptability of certain others either as preferred or as standard. The writer may tell us how the samples, or test pieces, are prepared; how the apparatus is set up; how the determinations are reached, or the results interpreted. In the case of some materials, oil, for instance, the discussion of the dozen or dozen and a half standard tests is in itself enough to make a respectable article; and the same is only less true in the case of cement and of certain fabrics. In any case, the treatment of the subject proper will be limited to the body of the article. The organization of this division presents here no new problem, unless it be that the author chooses to write in a succession of semi-isolated paragraphs. This will not affect the large divisions, but will lead to a beginning of each paragraph with the term to be discussed therein. But as to this, let the paper do what it will, so long as it is not loose, fragmentary, ill-organized, and does not have non-coordinate subdivisions and long strings of heterogeneous details; so long, once more, as it is not empty and commonplace, devoid of information, and sterile in point of interest.

Having disposed of the body, the writer is ready to consider such auxiliary matters as the introduction and the conclusion, the illustrations and the bibliography. Every paper should have some word at least of introduction. If the article is short, the direct type will serve, consisting of the barest definition and division; if it is longer, what is called the indirect introduction will likely prove most advantageous. Indirection, be it remembered, implies here no departure from pertinency or relevance. In the latter sort, the writer begins by some reference to the inception of his article, telling whether it was prompted by some earlier paper, by some recent record or report, by some significant development or discovery, or by some favorable opportunity enjoyed by him for personally adding to his knowledge of the subject. Possibly he takes occasion to note his attitude toward present opinion and practice and to suggest whether in general he aims merely to present this, to supplement it, to support it, or to tear it down.

If the subject is unfamiliar, or possibly in any case, he may give a brief preliminary definition, touching, it may be, on the etymology of the word—say, *helium, asbestos, nickel, rubber, "pig" iron, portland cement, Genelite, permalloy.* Thus he will prepare us for further definition—from the dictionary, or from some other authority or authorities; or, from the results of his own investigation and research. This he may supplement by a historical sketch of the material in question; telling how long it has been known and used, and what changes have from time to time come about in its production and utilization. If it is artificial, he may tell by whom it was invented, or by what succession of steps its development has been brought to pass. Under certain conditions, the introduction is a proper place to mention the geographical distribution of the raw material, and the sources of the chief supply; to speak of the extent of these natural resources; of the conditions under which they occur, and of methods of mining, transportation, manufacture, storing, marketing, etc., in so far as in the case at hand these become significant. Finally, the mention of costs and values may serve to bring home to the hearers the reality and significance of the subject.

This brings the writer to the formal division, or partition, with which every expository introduction well may close; for never yet has an expository paper been the better for the omission of some preliminary statement of its limits or intent, or of the main points and sequential order to be observed in its development.

The conclusion always presents a problem. The one thing we know about it is that it should permanently link the one article with the one occasion, with the one audience. Among the things it may do is to recapitulate or review what has been presented. It may likewise stress the significance of the material discussed to modern life; the upward or downward trend of its utilization; or the extent to which this utilization is affected by important developments either within or without the industry mainly concerned. It may again stress financial considerations, or it may make some definite local application of the facts presented. To the last sentence, which summarizes the summary, the writer

may well devote the greatest pains. Whatever may be the conclusion chosen, the audience must be made to feel that what they have heard is important, and that this presentation is likely to become a starting point and point of frequent return and reference in all their future discussion of the material.

The value of pictures, graphs, and tabulations, provided they are selected judiciously, cannot be overestimated. Even better, because more real, is the use before an actual audience of samples in the round and of any other exhibits that can be made to establish through the eye the mind's immediate contact with the object.

A bibliography, either comprehensive or select, will usually be appreciated by those who read any article. If this is included, a word or two regarding the content and value of the references may well be used to supplement the bare statement of their names.

Finally, as a further suggestion of the extent of this field of materials, we list the following:

alcohol, anthracite, asphalt, bauxite, varite, bitumen, brass, carbon, carborundum, cast iron, chalk, chromium, clay, coal, cobalt, copper, diaspore, duraluminum, emery, enamel, fluorspar, glue, gravel, hickory, iodine, lead, lignite, limestone, maconite, magnesite, magnesium, marble, oil, paint, peat, porcelain, potash, puzzolan, quartz, quicklime, quicksilver, radium, salt, sandstone, silenium, silica, slate, spiegeleisen, structolite, tar, tin, titanium, tungsten, vanadium, varnish.

No attempt is made here to include the endless compound titles, no less interesting than they are numerous, that might be used to expand this list; such, for example, as,

diatomaceous earth, German silver, red lead, vitrified clay, white pine.

The Properties Article

At the end of this chapter a listing of certain properties may be welcomed, if for no other reason, to serve as a basis for their differentiation. We have in the first place two large divisions,—those properties dependent on what we may call the "constitution" of the material, and those which are dependent on the "composition" of the material. The

first we think of as physical or mechanical qualities, and the second as chemical qualities or chemical reactions. Because of the present length of this chapter, and the highly organized state of present-day chemistry, we shall largely confine our attention in this section to an analysis of the former group.

Physical qualities are determined in two main ways: first, by a proximate, sensuous inspection and examination; and secondly, by an ultimate, scientific, analytical investigation. That is, we can for ordinary purposes form opinions regarding them by noting their appearance by a glance or by trying their condition by a testing with the hand. The optical examination informs us regarding their shape or form—whether they are *crystalline, granular, laminated, fibrous,* or *amorphous;* regarding their size, whether *large* or *small*—or in the latter case, merely *minute,* or *infinitesimal.* It informs us again regarding their light and their color, whether on the one hand *transparent, transluscent, opaque, opalescent,* or *vitreous;* or on the other, *black* or *white, red* or *blue* or *green.* The tactual examination acquaints us of their texture and weight and workability—first, whether they are *fine, dense, smooth, loose, compact, pasty, spongy, uniform,* or *homogeneous;* then, whether they are *light* or *heavy,* or of some definable ponderosity in between; and, once more, whether they are *sound, solid, tough, hard, stiff, rigid, fragile, brittle, flexible, pliable, friable,* or *sensitive.*

In case, however, we desire to arrive at some more exact opinion regarding the physical properties of a substance, we have recourse to a more exhaustive trying and testing of it, first by a further noting of its state in the form in which we have it, and then by watching the changes that attend some controlled alteration of this state. The first tests, applied to solids, tell us of their *density, plasticity, consistency,* and *specific gravity;* as regards liquid they show *porosity, lubricity, viscosity, fluidicity, solubility,* and *capillarity;* as regards air and gases they show *purity, humidity, volatility, combustivity,* and the like; as regards heat they show *fusibility, combustibility, conductivity, emissivity,* and *absorption;* as regards electricity they show *conductivity,*

again, *polarity, permeability,* and *radio-activity.* Alterations of state may be applied to solids or to liquids, to air or to gases. In the first case, a subjection to change of body gives *reduction, separation, dissipation;* and a subjection to change of position gives *vibration* and *agitation.* But the subjection may be to the elements: to liquid, giving *hydration, saturation, emulsification, absorption, liquefaction, flocculation, distribution, dispersion, coagulation, precipitation, solution,* and *suspension;* to air, giving us *desiccation* and *oxidization;* to light, giving us *illumination;* or to electricity, giving us *electrification, magnetization, polarization, resistance, inductance, insulation, magnetic reluctance, hysteresis loss, dielectric strength, electrocyclic action,* and other terms. Finally, subjection to heat gives *fusion, ignition, combustion, radiation, emission, expansion, contraction, cementation, carburization,* and *calcination,* involving incidentally the use of such compound terms as *burning point, freezing point, melting point, point of decalescence.* In the case of liquids, this alteration of state gives *evaporation, aeration, vaporization, distillation, solidification;* in the case of air or gas, *purification, humidification, occlusion, exhaustion,* and *compression;* and in the case of light, if we may regard this as a material rather than as energy, *reflection, refraction,* and *dispersion.*

This exhausts our first minor classification, that dealing with the physical constitution of substances, and brings us to the second, bearing on their mechanical constitution. Here again we have the possibility of either a proximate, sensuous examination, or an ultimate, exhaustive, scientific investigation.

The first can be conducted by optical examination of test specimens by the microscope, or by trying out these specimens by some form of manipulation. The microscope reveals amorphous and crystalline structures known as *eutectic, pearlitic, Martensitic, Austenitic, graphitic, ferritic, cementitic, sorbitic,* etc.; the manipulation indicates degrees of *ductility, resilience, elasticity, imperviousness, refractoriness,* and *resistance.*

Our acquaintance with the nature of materials, once more, may come from our observation of their reaction to

either natural or artificial injury. The former may affect the surface as *weathering, corrosion, oxidation, pitting, scaling,* or general *wear;* or the internal structure as "strain and stress"—manifesting itself under scientifically controlled conditions as *deformation, deflection, dislocation, elongation, compression, disintegration.* The latter, or artificially produced injuries, which likewise affect either the surface or the interior structures, include, of course, certain of the preceding, and besides, in the first place, *friction, abrasion, scarification, indentation, penetration;* and in the second, resistance to tension—as *tensile,* or *cohesive strength;* to compression—as *crushing,* or *compressive strength;* to shear —as *shearing strength;* to flexure—as *flexural* or *bending strength;* to torsion—as *torsional strength;* and to shock—as *impact strength;* and possibly also to resistance—as the *dynamic strength* manifested in explosives.

Similarly we might go on to analyze our second grand division, and give the proximate and ultimate description of chemical qualities and reactions, passing in review all the *-ity,* and *-itics, -ism* and *-ation* words that there are found.

The terms in these lists afford excellent subjects for investigation, whether taken singly, in pairs, or in smaller or larger groups. They may be amplified in various ways,—by definition and particularization; by citing examples and instances; or by comparison or contrast. The ideal in these short writeups should be extreme accuracy of detail,—pertinence, and quantitative exactitude in every illustration and comparison.

An Analytical Article

Particularly well adapted for analysis are the several branches of engineering, such as,

aeronautical, agricultural, automotive, chemical, civil, communication, consulting, drainage, efficiency, electrical, explosives, heating and ventilating, highway, hydraulic, illumination, industrial, irrigation, marine, mechanical, metallurgical, military, mining, municipal, radio, railroad, refrigerating, sanitary, steam-power, structural, telephone, testing, transportation, water-power, and water-supply.

In this paper the introduction might well relate the branch of engineering in question with the larger field of

science, and then with allied branches of the profession. After this it well might indicate the larger aspects of the branch under consideration. Following this, again, might properly come a historical note, sketching the main facts of its origin and development; and leading up to the last feature,—a statement of the heads to be discussed.

The body of the paper might present an analysis of the field, setting forth its component parts under a carefully coordinated scheme of divisions and subdivisions. The conclusion might well devote itself to the significance of this branch; to an outlining, perhaps, of its scope and status; or again to a pointing out of its requisites of endowment and education, or of the rewards it offers both in remuneration and in opportunity.

Topics affording a chance for similar practice in analysis, though sometimes on a more restricted scale, are the sciences closely related to engineering, for example:

> accounting, chemistry, bacteriology, dynamics, economics, electrochemistry, geodesy, geology, hydraulics, hydrodynamics, hydrokinetics, hydromechanics, hydrostatics, kinematics, mathematics, mechanics, metallurgy, meteorology, mineralogy, physics, thermodynamics, thermostatics;

and, on another level still, such peculiarly engineering terms as,

> construction, electrification, evaluation, installation, operation, organization, specification, transportation, power transmission, water purification.

The General Article

In our advance toward possible originality of treatment we come next to an order of topics whose outline is not to be found in the stereotyped pattern of the thing itself so much as in the conception of the thing that may exist in the individual mind. Here we find the unrestricted topic "engineering," and topics in which the term is limited in such ways as the following:

> Engineering as a career, Engineering education, The profession of engineering, Engineering as a profession, The qualifications of an engineer, Requisites to success in engineering, The trend of engineering education, The engineer and the community, The engineer's place

in modern industry, The ideal county engineer, Our indebtedness to the State Highway commissions, The engineer of fifty years ago and of today, Development of sanitary engineering since 1875, The engineer and the public utility, The interrelation of the several branches of engineering, National engineering societies, Engineering literature.

The preceding subjects, all of them concerned with engineering, and those subjects of a more miscellaneous character that follow, are no less suited for oral presentation from a prepared outline than they are for presentation in the written form. The following list is included merely to suggest the wide range of engineering material both interesting and important that is available for the purposes of composition:

Fuel, Friction, Power, Lubricants and lubrication, Explosives, Steam analysis, Highway classification, Commercial electricity, Railroad rails, Railroad curves, Telephone cables, Road surfacing materials, The strength of materials, Reinforced concrete floor construction, Electrical distribution systems, Public water supplies, Modern dams, Bridges, Bridge abutments, Prime movers, Mechanical bearings, Diesel engines, Hydraulic turbines, Electrical machinery, Current-measuring instruments, Farm water supplies. Planning a water-works system (—a sewerage system), Designing a filtration plant (—a sewage-disposal plant), Zoning in a town of twenty-five thousand, The lighting of streets and highways, The maintenance of dirt roads (—of concrete roads), Time study in a factory, Gravel-plant operation, Making a sanitary survey, Making a traffic analysis, Flood control, Municipal sanitation, Motor-vehicle control, Biological control of impounding reservoirs, Motor-truck maintenance.

The problems presented by such topics as these are different in no material respect from those treated earlier. They should be defined, and analyzed, restricted to a certain scale, and then discussed step by step with conciseness, accuracy, and completeness.

CHAPTER XVIII

NUMERALS

Expressing as they do such important conceptions as quantity and value, numerals require to be written with the greatest care. Painstaking attention should always be given to forestall any doubt arising from their shape, pointing, or association with one another. Regard should also be paid to the conventions regarding written and figured forms, the arabic and roman notations, the cardinals and ordinals, the fractions and decimals.

Figured numerals find their chief value in their brevity and consequent convenience and salience of appearance, and in the fact that, being always associated with mathematical conceptions, they bring such ideas more immediately to the mind than do the spelled-out forms. As numbers increase in size or in complexity, this advantage becomes more and more evident. The spelled-out forms are useful for the reason that they do not break the course of literary prose; because of the fact that they are less liable to mistake or mischance than are the figured ones; and because, again, they can at need be written beside the figured forms without resulting ambiguity.

Arabic figures are used generally in computations, in enumerations, and in all specific and accurate expressions of value, relation, quantity, and dimension. They are used arbitrarily to designate the sequence of illustrative figures, and of such minor textual divisions as sections and paragraphs. We find them also used with the abbreviation "No." for number.

The absence of an integral unit with a decimal should always be indicated by a single cipher to the left of the decimal point, thus 0.10 per cent. The placing of a cipher at the end of a decimal indicates a reading correct to that

place; e.g., "1.250" shows a decimal reading correct to three places.

Roman numerals serve in their lower-case form to list the introductory pages of books; and capitalized, to mark such larger divisions of literary productions as volumes, books, chapters, appendices, or articles. They are used for listing of tables and plates; for marking dates on corner-stones; and frequently for designating the grades of materials.

Usage in Writing Numbers

Numbers are variously punctuated. Roman numerals require periods after them when they are used in outline work, but not otherwise. Arabic figures take a period (the decimal point) between an integral part and any fractional part. Numbers over ten thousand when written in the arabic form take a comma after every third place to the left —that is, on the integral side—of this point, but not on the right, or fractional side. Street numbers and license numbers do not take this comma; but do, frequently, as also do tables, make use of a space and sometimes even of a hyphen or a dash at convenient points. The superior letters st, nd, etc., used to indicate ordinal forms do not take the period.

The plurals of figures, like those of letters, are generally indicated by the addition of the apostrophe and *s* ("all the 9's"). Less frequently they are written by simply adding *s* to the figured forms. When numbers are spelled out, the plural is of course formed by adding *s* to the singular.

Parentheses inclose figures used as symbols to mark headings in text; as also they do figures introduced for surety after written numbers. Here the form in parentheses should be placed immediately after the term it modifies; thus, "five dollars ($5)," or "five (5) dollars."

The dash is used to connect the first and last of a series of consecutive numbers, the word "inclusive" being in this case superfluous. Sometimes dashes are used instead of commas to separate the items of a series, as where these express the firing order of cylinders.

The hyphen joins the parts of compound numbers, both

cardinal and ordinal, between 21 and 99; also of the compounds "ten-thousandth," "hundred-thousandths," etc.; and again, of the spelled-out compounds expressive of the hour and minute of the day, e.g., "one-thirty." Simple fractions, when spelled out, require the hyphen in adjectival but not in nominal forms; thus, "Two thirds of the men received less than two-thirds pay." Compound adjectives having a number in the first place require a hyphen just as do any other compound adjectives. No "suspension" hyphen is necessary after the penultimate figures in such a sequence as "4, 6, and 8-in. bolts." The rule that hyphens are required in compound adjectives does not hold for such numerical forms as "forty thousand residents," "a four million production," or "28 million acres"; and even its use throughout such ordinal expressions as "the one[-]hundred[-]twenty-first hour" appears excessively academic. The use of the hyphen in two different senses in such expressions as "a one-quarter-inch tube" and "a twenty-four-hour test" is unfortunate; it can frequently be avoided by turning to the forms "a ¼-in. tube," and "a 24-hour test."

The colon (less frequently the period) is used to separate the hour and minute, or the hour, minute and second, of the day when these are figured; thus, "7:45"; "7:45:23" (also "7.45.23"). The colon also is used to separate the items in a proportion, as of a slope or of a concrete mix.

A line slanting from the right down to the left is used in typewriting (and sometimes also in handwriting and printing) fractions whose denominators are greater than 10, to separate the numerator from the denominator.

The Phrasing of Numerals

Sometimes a moment's hesitation occurs over the proper phrasing of numerals or of various locutions used in connection with numerals. A few of these we shall call to mind in this section. "*Fewer* than one hundred," where number not quantity is concerned, is to be preferred to "*less* than one hundred"; but with "more," as in the phrase "not *more* than 15 or *less* than 12 times," the word "less" ap-

pears defensible. "Lines one inch *or less* in length" is more elegantly worded, "lines not exceeding one inch." Care should be taken in all such phrases to include or to exclude the limit; cf., "Lines less than one inch," or "lines exceeding one inch." "As much as," once more, expressive of quantity, should not be interchanged with "as many as," expressive of number. In this connection we remember that after any term that gives a negative effect to the phrase "as many . . . as" takes the form "so many . . . as." We should also bear in mind the differentiation between "most all the streets (incorrect)," "most of the streets," and "almost all the streets."

The number of the verb is in many cases dependent on whether one desires to express the notion of a collective, united whole, or the notion of the several separate, counted, perhaps distributed items that are comprehended by this whole:

Ten per cent of both aggregates was rejected.
Ten per cent of the shovels were rejected.
The number of the machines was carefully noted.
A number of machines were unable to continue.
Ten yards is about the right distance.
Ten inches were spaced off accurately to the left.
Twelve miles of pavement was included in this contract.
The three miles of paving between the town and the river were sublet under three separate contracts.
Twenty-three pounds were thus distributed.
Twenty-three hundred pounds was the total weight.
Twenty-eight loads of No. 4 stone chips was thought sufficient.
These twenty-eight loads were deposited at intervals along the drive.
Six tons per boiler is the hourly consumption.
Six tons are simultaneously deposited in these hoppers.
At this price for excavation $10,000,000 means 40,000,000 cubic yards.
Ten million cars are equivalent to one for each five persons of the population.

Fractional numbers, including those with numerators of 1 in the form "one half the men" or "one third of the castings," take a plural verb when whatever is spoken of is considered individually—item by item. Fractions, including those with numerators above one, take a singular verb when the reference is collective. ("Three fourths is sufficient.")

The figure *146* is read "one hundred forty-six," without the "and"; and *1928* is read "one thousand nine hundred

twenty-eight," without "and's" or commas; or, usually in the case of a date, "nineteen hundred *and* twenty-eight." In any casual reference, say, to "7500 miles," we do well to say "seventy-five hundred miles," rather than "seven thousand five hundred miles." Two million gallons should never be written "two million of gallons," and "within one part in two million" should not be written "within one part in two millions."

Fractional forms are phrased with the word "and" only between the integer and the fraction. The word "one" should *not* appear in reading such *decimals* as the following: "two *one* tenths," "two *one* hundredths," "two *one*-hundred-thousandths," "one *one*-hundred-millionth"; but in reading a fraction written with a numerator and a denominator this "one" is more defensible. Thus we write:

0.01 in., one hundredth of an inch
1.01 in., one and one hundredth inches
2.02 in., two and two hundredths inches
109.01 in., one hundred nine and one hundredth inches
0.016 in., sixteen thousandths of an inch
0.666, six hundred sixty-six thousandths
600.066, six hundred and sixty-six thousandths
123.0001, one hundred twenty-three and one ten-thousandth
1124.0135, one thousand one hundred twenty-four and one hundred thirty-five ten-thousandths
0.0000065, sixty-five ten-millionths
4.00000654, four and six hundred fifty-four hundred-millionths
40/65, forty sixty-fifths
1/365, one three-hundred-sixty-fifth
182/800, one hundred eighty-two eight-hundredths
40/250, forty two-hundred-fiftieths
42/150, forty-two one-hundred-fiftieths
42/1000, forty-two thousandths, or forty-two one-thousandths

Orally one often hears the readings:

3.1416, three, point, one, four, one, six
3.014, three, point, o, one, four
3.014, three, point, o, one, four
3.0000079, three, point, five ciphers, seventy-nine
"The rod reading was 3.20," three, point, two, o.

In shop practice where one thousandth of an inch is in common use such forms occur as 0.0002, two tenths of a thousandth; and again in mathematical parlance one hears such expressions as "six times ten to the sixth power" used for six million, but these scarcely concern us in this volume.

The Choice of Forms

Figured numbers

We come now to the problem of figured or spelled forms. Wherever, as in mathematics, numbers rule, figures prevail over written words. Thus we expect to find them in computations and tabulations, in references to the number of votes cast at an election, and in casual references to cardinal numbers used as nouns. Figures likewise are used in statements of ratios and proportions, and of extreme limits when numerically expressed; and in the designation of the members of a series, such as listed objects, or items of production, or numbered banknotes, post-office boxes, maps, plans, vehicles, models, problems, investigations, organizations, sessions of organizations, and the like; also in enumerations of stations, positions, house sequences and room sequences, telephones, licenses, the volumes of books, bulletins, periodicals, etc., and of the sections, articles, pages, paragraphs, etc., in such productions.

Reason recommends the use of figured numerals in textual passages of a statistical nature where ideas of number appear repeatedly and, as it were, dominate the thought; and this for the reason that figures present quantitative ideas as such, and with all possible salience and distinctiveness. In such passages expressions of like character should always be written in the same way. Where, however, two sets of figures are running simultaneously, the putting of one set in words and the other in figures often makes for clearness; as in the example below: "The following size manholes are approximately correct: for a four-duct line, 6 by 8 ft.; for a six to nine-duct line, 7 by 7 ft.; for a twelve to sixteen-duct line, 8 by 8 ft." Finally, good sense favors the use of figures in the writing of any number that is so large or so complex as to require four, or usually even three words, for its expression. Some latitude, however, must always remain in such cases for the exercise of judgment. The rule that every number in the first member of a compound adjective should be written as a figure is surely ill advised, for we see "three-place decimals" about as often as "3-place decimals";

and "three-ton trucks," "three-year contracts," "three-ply ropes," and "three-phase lines," are all about us.

Spelled numbers

Text we are accustomed to find in written words, and in as much as any number *can* be expressed verbally, in continuous composition the burden rests on the writer to show in each case why number forms should not be spelled out in full. Seldom, in fact, can a spelled-out form, simply for that reason be called incorrect.

Beginning a sentence with a figure is all but universally disapproved; where a number is so large or so complex as to be awkward in its verbal form, some slight recasting of the sentence will readily bring the number into a post-positive position. We note in passing that such writing out of any quantitative number prevents the abbreviation of any unit of measure that may accompany it.

Casual numbers, more particularly when they are only one or two words long, are spelled out; also, numbers used as pronouns; and numbers in fractional form when appearing either as nouns or adjectives or adverbs.

Ordinals are usually spelled when appearing as adjectival modifiers, as symbols in outline work, and as the first members of compounds, in which last case they are followed by a hyphen.

Cardinals telling the number of "times" are spelled out, if not figured for some special reason.

CONVENTIONAL USAGE WITH EXPRESSIONS

Measure and Count

Figured.—Exact ideas of number are regularly figured, as in the case of percentages (which usually, when they involve fractions, are given the decimal form), decimals themselves, and the larger fractions. As the decimal form of fractions is considerably more precise in its suggestion than the other form, for such an operation as concrete mixing, "the proportions 1.5 : 2 : 4" would probably be set aside for "the proportions 1½ : 2 : 4." Never should ordinary

fractions and decimals be mixed as we find them in "steel from 0.1 in. to 1¼ in."

Quantitative figures, especially when followed properly by an abbreviated unit of measure, are figured; for example, in expressions involving degrees of temperature; degrees, minutes, and seconds, of angular distance; dimensions, speed, capacity, weight, pressure, power, and the like. So written, notions of amount determined scrupulously, are seen at once and seen for what they are.

Spelled.—Little reason can be found for writing casual "count" numbers in anything other than the full spelled form. These modifiers, telling the number or quantity taken, are usually less vitally significant than are the dimension numbers; and, as a rule, also, less complex in their phraseology. This writing of the count number one way, and of the dimension number another, prevents confusion and ambiguity when the two happen to be contiguous. In case, however, the count is large or complex and the dimension simple, the former is figured and the latter spelled. Where both are awkward to spell out, they may both be figured, with a dash between them, thus, "1275 — 1⁵⁄₁₆ in. steel rods."

Vague or indefinite ideas of number, such as we refer to as "round" numbers, are regularly written in words, the better to avoid any improper suggestion of preciseness. The mere use, however, of such a word as "about" or "approximate" with a number which is still essentially precise, does not call for a writing out of an expression in full. Large amounts in even millions or in halves or quarters of millions or billions, may be conveniently written in a hybrid form with the noun, say "million," spelled out but preceded by a figured adjective.

Percentages, regularly figured, when stated as approximations should likewise be spelled.

Street Numbers

Figured.—House numbers are written in figures, as also are street names beginning with 100th Street. In the case of the latter, a dash separates the house number from the

name of the street, save where such a directional word as "North" or "East" intervenes. Where such directional words do occur, numerical street names below 100 ***may*** also be figured, this possibility making for convenience where an address happens to be of considerable length, as for instance, "349 North 13^{th} Street West."

Temporal Expressions

Figured.—As a rule, specific references to years, either alone, or with the month or the month and day; or to the day of the month together with the month, or together with the month and year; or to the exact hour and minute ("7:45 a.m."); or hour, minute, and second ("9:37:30 p.m."), call for figured numbers. In process papers and the like, exact references to the time required by various stages of the operation appear in figures; as also do limits of time when expressed in hours "a.m." or p.m.," or in successive or inclusive dates;—also, periods of time when set forth in so many hours, minutes, and seconds; or months, weeks, and days; or years, months, and days.

NOTE.—Good form approves "the year 1919" rather than "the year of 1919," and "March 10, 1928" rather than "March 10th, 1928"; still, in formal documents, we write, "Signed this the 4th day (or, fourth day) of March."

Spelled.—References to the century, to the year of the century, and casual expressions indicative of the time "o'clock," and of some length of time "past" or "after" or "of" the hour, are regularly spelled.

In social correspondence and in legal instruments, references to the day, month, and year are ordinarily written out in full.

Number words expressive of ages, of general limits of time ("within five days"), of the period or extent backwards of forward of time, or of frequencies or intervals of time, or of the "times" of occurrence, are more generally spelled out than figured.

Monetary Expressions

Figured.—Exact sums in dollars, more especially if large, and all sums in dollars and cents, are properly given in figures preceded by the dollar sign, no ciphers being added to indicate the absence of cents. Sums of less than a dollar should be given in cents, the amount being figured and the word cents spelled out in full.

Spelled.—Occasional sums in dollars alone, or cents alone, more particularly in writings of a literary character, are now and then found in written words; and less frequently, amounts containing both dollars and cents.

In legal instruments such as contracts and in formal business correspondence, monetary expressions are rather generally put in words for greater surety; and to make assurance doubly sure, are usually followed by the figured equivalent within parentheses; thus "four hundred dollars ($400)," "four hundred (400) dollars."

Millions and billions are here also sometimes written in the hybrid form of figures and words combined, in which case the dollar sign before the figure should give place to the written noun "dollars," or to the adjective "dollar," following the millions.

As in the case of other decimals, the "and" appears only between the dollars and cents; thus, "one thousand three hundred sixty-four dollars and thirty-eight cents ($1364.38)."

Admittedly, usage is far from standardized in this matter of numerical representation. Exceptions will everywhere be found to the practices here recommended. These practices are, however, in accord with the usage of many first-class publishers, and are fairly representative of reputable standard usage. To have some rule, and to follow it, is in any case, less demoralizing than to wallow in the slough of inconsistency and indirection. The character of the writing, as has repeatedly been suggested, largely determines the admittance or nonadmittance of figured forms. As the style turns away from *belles lettres,* toward science and its affairs, figured forms become increasingly more common. This fact, as also the occasional conflicting of rules, calls for the continual exercise of judgment on the part of the writer as to

what form in any particular case is likely to prove most in keeping and most intelligible.

Exercise.—Give reasons for the correctness or incorrectness of the following forms. Be able to write them from dictation.

1. MCMIX; Nos. 215-227; a ratio of 6:1; 1:2½:6 concrete; $\sqrt[3]{2} =$ 1.2599210
2. a ten-cent piece; £680, 10s., 4d.; Chapter V of Part I; a three-ton truck; Nos. 1, 2, and 3
3. readings of 0.0001 in.; 9½ by 9½ by 10 in.; the first of each month; two 10⅞-in. sleeves; from 10 a.m. to 3 p.m.
4. not over 0.04 per cent; we refer to Article VII; half a dozen reasons; an error of 0.003 in.; his seventy-first year
5. slopes of about 1½ to 1; only fifty-six years ago; by a vote of 52 to 18; at 711 Eleventh Avenue; $\pi = 3.14159265358919$
6. from 1s. 6d. to 2s. 8d.; in five equal payments; See pages 53, 60–64, 72; 550 million feet of lumber; in the early Eighties ('80's)
7. Two thirds of 27 is 18; 5460 six-inch shells; 1864 East 77th Street; for nearly eleven years; 6, 7, and 8-in. tires
8. two 240-hp. engines; over one third of the cost; the 1 7/16-in. snap piston rings; paragraphs 9 and 11; These keyways are ⅛ in. deep
9. a 3 to 5 per cent profit; about two fifths of the crucible; requiring from seven to ten men; a pressure of from 85 to 105 lb.; on page 28 in paragraph 6
10. over 125 types of machine; in three or four years' time; two shifts of six hours each; a rate of 11 cents per 100 lbs.; an allowance of one-half minute
11. 2½ parts sand to 1 part water; within fifty feet of the building; a decrease of 0.86 per cent; a fillet curve of ⅝-in. radius; 132 billion gold marks
12. 12 East Thirty-ninth Street; five 28 to 30-ft. sections; twelve hundred 4-in. pipe; Cancel the 3's and the 5's.; for three quarters of a century
13. The train starts at 7:28 sharp; at only one half the old rate; between 400 million and 475 million; his plan for a six-hour day; a total of 111,903, cu. yds.
14. They came in lots of twenty; errors of between 0.00075 and 0.0009; Company A, 3rd Regiment, 4th Division; in nine cases out of ten; over a hundred good reasons
15. The train leaves at about four-thirty; add the square root of 64; 30 lb. electrodes at 3 cents per pound; from 1:37 a.m. until 12:37 p.m.; the total number of votes was 3147.
16. The cost was $154 per mile; about one fifteenth of the amount; for one and one-half hours; six ½-in. square steel bars; The studding consists of 2 by 8's
17. the first nine months of 1922; men over forty-five years of age; every twenty-five or thirty minutes; prior to ten or fifteen years ago; a book of some three hundred pages
18. The work occupied sixty-three days; A saving of $426.30 per month; Salaries range from $140 up; an offer of three thousand for the device; Everything was at sixes and sevens
19. these 10-ton, six-wheel trucks; over 5,024,506,000 cu. ft. of gas; an average value of 3.7 cents; Signed this 4th day of March, 1921; The rod shortened only 0.009 in.

20. A four-months' course has been provided; The firing order was 1-3-2-5-8-6-7-4; the ten-year period subsequent to 1900; The new plant is on Fortieth Street; The first five years showed a loss

21. a period of about twenty-six years; about 265 four-by-seven-inch pages; a population of over fifteen million; Maintain an average slope of 1 to 5; Second, consider the tensile strength

22. the first session of the Sixty-second Congress; They use thirteen of these furnaces; Ten thousand cubic-feet-seconds of water are required; Six to eight ties per minute are machined; at from 70 cents to 84 cents per mile

23. from 1 in. to 1½ in. (25 mm. to 38 mm.); The log cosine of 3°99′ is 0.94912; Multiples of 1, 3, and 5 are disregarded; the rule given in Section 147; for smooth-face brick, 8 by 2¼ by 3⅞ in.

24. the east end of Forty-ninth Street; Fig. 3; Tables I and II; Plates V–VII; no less than 28 million acres of land; Reports shall be made within five days; a stretching of approximately 1¾ in.

25. They get three times the pay for half the work; a stress of 15,000 lb. per square inch; over 37.85 billion horsepower-hours; We arranged these by twos and threes; these 122 four-room, third-story apartments

26. This town is about 158 miles from Boston; Note the three reactions between the two; We conducted two 24-hour tests; hoops of 3-in. by 3/16-in. strap iron; a test section of about ⅝-in. diameter

27. a three or four-story apartment house; He earns now four or five times as much; the 13-odd billion gallons of petroleum; requiring from 1200-lb. to 1350-lb. pressure; This continued from the 9th to the 25th.

CHAPTER XIX

THE RELATIVE-MERITS TALK

- General coverage of the divisions.
  - Of the introduction.
  - Of the body.
  - Of the conclusion.
- More specific purpose of the parts.
  - Of the introduction.
    - Origin of the discussion.
    - Definition.
    - History.
    - Division.
  - Of the body.
    - Technical considerations.
      - Structure.
      - Operation.
    - Economic considerations.
      - Cost of installation.
      - Cost of maintenance.
  - Of the conclusion.
    - Summary and evaluation.
    - Conclusiveness of the findings.
- Comparative timeliness of composition assignments.
  - In liberal arts.
  - In engineering.

Here as always we have occasion for a three-divisional arrangement. The introduction covers as before the origin of the discussion, the definition of terms, and the history of the matter under consideration, together with an explicit statement of the intention of the paper and a listing of the heads under which the speaker purposes to take it up. The body occupies itself with a comparison of the two forms, that is, with a presentation of the factors to be considered

in making a choice between one or the other. The conclusion is, properly, a statement of conclusions,—a brief setting forth of the speaker's judgment regarding the relative merits of the types discussed. The entire treatment should be organic—as shapely in its outlines as a Grecian vase. It should be light and interesting in its beginnings, straight and strong down its sides; and it should stand firmly based, stable, in its conclusions.

More Specific Purpose of the Parts

The introduction finds a proper opening in some reference to recent discussions arising from the advent it may be of a rival method, or machine, or material, in a field long monopolized by some older form. Debates, let us say,—differences of opinion, have arisen relative to the technical merits and the economic advantages presented by these rival claimants. To this literature the speaker now adds his word in an attempt to weigh the rival claims, or to urge the advantages of one or the other, or to argue for the superiority of each of them under particular conditions that might and do arise. Then comes any necessary defining of terms, such as might seem called for in a talk involving, say, the *dragline, heartwood* and *sapwood, pulverized fuel, vibrolithic pavement,* or the *mercury-arc rectifier.* The audience is better prepared to follow the discussion if it is also given the main facts, descriptive or statistical, regarding the development of the two forms.

Now, with the subject properly defined, with its historical outlines well in mind, with a rather definite idea regarding whether the treatment is to be expository or controversial, the audience is at last prepared for a statement of the specific points that the speaker has in mind to discuss. This treatment should be systematic and well considered. One form must of necessity take precedence over the other; one must be *a,* the other must be *b.* The choice of which is which is not altogether a matter of indifference. The possible lines of orderly procedure in presenting these terms are not a few. For example, the entire treatment of *a* may precede the entire treatment of *b.* Again the advan-

tages of *a* and *b* may precede the disadvantages of *a* and *b*. Successive details of *a* may be placed in comparison with corresponding details of *b*. The advantages and disadvantages of *a* may be weighed, and then compared with the advantages and disadvantages of *b;* and again the advantages of *a* and *b* may be grouped, and matched against the disadvantages of *a* and of *b*. Finally, to mention only one other of many conceivable combinations, the technical aspects, sufficiency, and advantages of *a* and *b* may be weighed against the economic criteria of availability, cost, and the like. The important thing is for the author to realize that very real differences of effect lie in these several forms—that the psychological reaction to one presentation may be quite different from the reaction and response to another.

With such a range of subjects as is here presented, any attempt to dogmatize regarding the outlines of the body of the article is pretty certain to prove futile. Merely to illustrate one orderly form of procedure, however, let us imagine two grand divisions into, first, technical, and then, economic, considerations. The first would have to do, let us say, with the composition or construction of the thing discussed, and after that with its operation or endurance. The second would concern itself with initial cost, and fixed charges; and along with these with the variable expenses incidental to maintenance. Under construction would come such items as simplicity of design, ease of installation, size and weight, strength and stability. Here also might be mentioned matters of appearance, of cleanliness; and such other points as flexibility, and adaptability to expansion or changes in capacity. Improvement in the product or in by-products are also what we may call *considerata*. Under operation, simplicity comes up again, together with convenience; and with these are associated ease of control, automatic features, safety features, speed of operation, adaptability, dependability, resistance to deterioration, and ease of repair. Altogether, an interesting list, these, and one made up of items very general in their applicability.

The second main head would have to do with the cost of installation and with such standing expenses as interest, taxes, bonds, insurance, and depreciation, on the one hand;

and on the other, with production and deterioration and replacement costs. To support all assertions by statistical data showing in quantitative graphical fashion relative performance and efficiency and economy of operation, then to offer convincing evidence of the trustworthiness of these data is to add weight and impressiveness to the presentation.

The results of the comparison appear in the conclusion. This may be merely a pointing out of the factors that should govern any choice between the two; or it may be a restatement of the author's opinion regarding the superiority either generally or under particular circumstances of one or the other. The choice may depend upon local conditions, upon the size of the installation, or the facilities obtaining in the plant; it may again depend upon the expense involved in the change or on other purely economic factors. These points might well be supplemented by some note on the trend of the times; supported on the side of theory by the opinion of experts of recognized authority, and on that of practice by adoption and installation by influential named concerns.

In concluding his conclusion the speaker might indicate the degree of confidence with which his judgment is expressed, and the extent to which his opinion appears to be final and definitive. Possibly he may see a solution of the difficulty of choosing one or the other in some third alternative; thus composition as a laboratory floor might supplant both wood and concrete; and the Diesel heavy-oil engine might for a given purpose promise better than either the reciprocating engine or the steam turbine. Eternally true it is, particularly in science, that the end is not yet; and the part of wisdom is to watch the course of evolution and pick, as best one may those forms fittest to survive.

Timeliness of Composition Assignments

In selecting subjects for composition, the Liberal Arts student too often searches back into the cast-off things of boyhood; whereas the student of Engineering reaches forward toward that order of topics which concerns the man. Too often the former prove dead and inconsequential; and,

being this, fail utterly to awaken the interest and elicit the effort of the one who writes. In contrast, the engineering subjects are of vital present-day concern; they are related to reality, and such as would naturally stimulate one's best efforts.

The range of topics available for this exercise is merely suggested by the following list:

> Aluminum vs. steel; Synthetic rubber vs. natural rubber; Copper-alloy steel vs. plain steel; Chrome-nickel vs. manganese steel; Acid open-hearth steel vs. basic open-hearth steel; Vibrolithic vs. plain concrete paving; Hardwood vs. granolithic floor surfaces; Pulverized vs. lump fuel; Brass vs. iron pipe; Balloon vs. high-pressure tires. Trolley wheels vs. sliders; Electric vs. combustion furnaces; Steam vs. electric-power shovels (locomotives); Four-wheel vs. six-wheel trucks; Rotary vs. centrifugal pumps; Slow sand vs. rapid sand filters; Uniflow vs. duoflow engines; Wood-frame vs. steel-frame windows; Spray vs. brush painting; Welding vs. riveting; Automatic vs. manual control; Oxy-acetylene vs. electric-arc welding; Water power vs. steam power; Metric vs. English system of weights and measures; Five-day vs. six-day week; Municipal vs. contract labor (control of materials).

CHAPTER XX

THE ARGUMENTATIVE PAPER

Importance of argumentation in engineering practice.
- The prevalence of arguments.
  - Regarding the practicability of procedure.
  - Regarding the method of procedure.
- The significance of arguments.
  - Large considerations involved.
  - Consequent demand on those in control.

The essentials of argumentation.
- The nature of argument.
  - Aim and classification.
  - Evidence and reasoning.
- The parts of an argument.
  - Shaping the introduction.
    - Through approach to audience.
    - Through definition of terms.
    - Through statement of issues.
  - Shaping the body of discussion.
    - To effect conviction.
      - By handling of evidence.
        - Setting forth reasons for belief.
        - Anticipating objections.
      - By indicating progress.
        - Transitions.
        - Summaries.
    - To effect persuasion.
      - By tactful choice of material.
      - By personal appeal.

Ideals of argumentation—The impressions
- Of cogency, cumulation, and climax.
- Of good sense, balance, and judgment.

The engineer among his practical affairs is always likely to be drawn into argument. With every project arises dis-

cussion as to its value and practicability; and the settling of the main question of whether or not it shall be attempted raises further questions born of the differences of opinion regarding possible methods of procedure. Arguments are carried on upon levels quite diverse. National questions, we have, of irrigation and flood prevention; state and divisional questions, of power development and highway improvement and internal waterways; we have municipal questions of paving and zoning, of sewage disposal and traffic control. The rival interests that build up country and city make much in all their councils of the wisdom of the engineer.

The engineer is not a debater; in argument he is the fighting man and not the boxer. The discussions in which he engages are practical, not theoretical. Often and again we find them involving not only prestige but fortune; and on whatever level they may be carried out they become matters of immediate concern. It follows, naturally, that the engineer should know something of the technique of controversy. So extensive, however, is this subject that we cannot here develop it as it deserves. The engineering student should take up the matter by himself as thoroughly as he is able; and in doing this he may best make himself familiar with such texts as the following:

Baker, George Pierce, *Principles of Argumentation.* Ginn & Co., Boston, 1902.

Baldwin, Charles Sears, *A College Manual of Rhetoric,* Chapter III. Longmans, Green and Co., New York, 1909.

Denney, Duncan, and McKinney, *Argumentation and Debate.* American Book Co., New York, 1910.

Foster, William Trufant, *Argumentation and Debating.* Houghton Mifflin Co., Boston, 1908.

Graves and Spotts, *The Art of Argument.* Prentice-Hall, Inc., New York, 1927.

Laycock and Scales, *Argumentation and Debate.* The Macmillan Co., New York, 1907.

MacEwan, Elias J., *The Essentials of Argumentation.* D. C. Heath & Co., Boston, 1907.

Pattee, G. K., *Practical Argumentation,* revised ed. Century Co., New York, 1925.

The purpose of this chapter is to sketch in outline the body of doctrine presented by these authorities.

THE ESSENTIALS OF ARGUMENTATION

In the first place we are concerned with the nature of argument. It is the art whereby one moves others to one's own way of thinking and acting. By MacEwan it is defined as "the process of proving or disproving a proposition. . . . An argument is any proof—fact, testimony, circumstance—put forward to induce belief in the truth or falsity of a proposition"; and by Pattee as "the art of presenting truth so that others will accept it and act in accordance with it. Debate is a special form of argumentation; it is oral argumentation carried on by opposing sides." Arguments are generally classifiable as those of fact and those of policy; the former being concerned with the occurrence or with the non-occurrence of phenomena; and the latter with the advisability or expediency of doing this or that. The former oftentimes are susceptible of demonstration or disproof; the latter, dealing as they do with what "should" be done or "ought" to be done, forever remain, in part at least, in the realm of supposition and opinion. (See Pattee, *op. cit.*, pp. 20, 63.) As Professor Baldwin puts it, although certainty may be the ideal in argumentation, it is practically impossible of attainment,—

> "We must in most cases act on generalizations short of certainty, it is toward such generalizations that we direct our argument. . . . All that we can attain—and since it is enough to act on, it is enough to prove—is what we call practical sufficiency. . . . Practically, then, a proposition is said to be proved when the process of proof, having been carried as far as is practicable, leaves in men generally no doubt. This is the highest degree of practical sufficiency." (*Op. cit.*, pp. 88–89.)

The arguing of propositions consists in the marshaling of what is called "evidence." Evidence, MacEwan defines as "the general name for whatever is brought forward to substantiate a fact or establish a proposition." "In its broadest sense," Denney says, "evidence includes everything that is submitted for the purpose of proving or disproving a proposition"; or, to quote Foster, "Evidence is everything which ought to bring or tend to bring the mind to the conviction of the truth or falsity of a proposition." Clearly,

with these materials and underlying causes of belief, the engineer has deep concern, He will, therefore, do well to cultivate a habit of looking for evidence, *as* evidence, and of mentally registering the scheme of facts by which this or that proposition can be tested out.

Arguments are based upon "deductive" or "syllogistic" reasoning when they progress from accepted truth or laws or principles to what should follow or be established as a result of the operation of these principles; and they are called "inductive" or "inferential," when they go from newly collected data to the laws or principles assumed to be established by these new facts. Rules for the application of the latter sort of reasoning have been set forth at once comprehensively and succinctly by John Stuart Mill in his five canons of inference, a convenient statement of which may be found in Laycock, pp. 117, 118; also, in Baldwin, pp. 78–82; and in Graves, pp. 37–47, 82–84.

Arguments arise solely over "propositions," which are grammatically complete sentences regarding the being or non-being of certain subjects of thought; and these propositions, in turn, are composed of words or phrases themselves susceptible of discussion but not of debate. The terms of an argument should be unambiguous and sharply definable; the proposition should be positive, not double or multiple; and in its ultimate determination, absolute, not comparative. Only as a proposition is brief, timely, and important will it afford incentive for lively discussion, and hold out the promise of any substantial gain as the result of its deliberation.

Inasmuch as the very warp and woof of argument is composed of evidence, the writer in this form should spare no pains in seeking assiduously through all possible sources where material bearing on a proposition may be found. Argument is contest; and its materials are the very sinews of war. Although in searching out such data, investigation gains an incentive and an intensity not found in exposition, in kind the two are in many ways not essentially different. Accordingly, the directions suggested for expository investigation will here in general apply. If any qualitative difference exists, it will lie in a more rigid exclusion of irrelevant matter, and in a stricter scanning of all matter clearly

pertinent with a view to determining the extent to which it can be depended upon to carry conviction. Relative values are here everything; and the reader will, as he reads, sift and assay and eliminate accordingly. In Foster's words, the debater

"Should read, read, read. He should think, think, think. And all the time he should be judiciously selecting, weighing, comparing, rejecting. He should collect a mass of material and finally throw away most of it. Let all the good pieces of evidence struggle for places in the argument. The law of selection must be the survival of the fittest." (*Op. cit.*, p. 77.)

The Parts of an Argument

The business of the introduction, once more, is *"reddere auditores benevolos, attentos, dociles"*—to render the hearers kindly disposed toward the speaker, attentive to his utterance, and ready to listen with open, teachable minds to whatever he has to communicate. But besides securing the willing attention of his auditors, the speaker should strive, in the introduction, to impress them with the fact of his ability, his mastery of the subject, his sincerity; and he should, moreover, make a definite effort to awaken in them an active interest in the question he is about to open up. In formal argument, the sequence of topics in the introduction is almost a stereotyped one—become so, be it noted, not by any arbitrary ruling but as the result of men's experiences in incalculable controversies. This order is typically as follows: (1) some reference to the immediate cause of the discussion; (2) a résumé of the question; (3) the definition of any difficult terms used, or implied, in the proposition; (4) the restatement of the question as thus defined with a view to the more exact determination of its inherent identity; (5) a possible setting forth of the opposition of opinion represented by the parties to the argument, which consideration leads in the end to (6) the bringing up of the "issues" of debate, that is the statements of fact regarding the proposition to which the adherents of the two sides would return answers diametrically opposed.

The whole point of the argument itself is to array evidence which shall amount to conclusive proof for or against

these several issues. Clearly, before any argument can proceed, the opposing parties must agree at least as to the question they are debating; hence the importance of the strong element of definition. Both sides should recognize that in the introductory exposition they meet on common ground; and accordingly, in this section they should avoid any suggestion of biased or prejudiced representation. All-important in any course of argument is the discovery of the issues. One of the most effective ways of accomplishing this is to probe the subject with questions from every angle, and then to eliminate all questions upon which the two sides would find themselves in substantial agreement. Implicit in those questions that remain are the issues sought; as a rule they are changed from the interrogative to the declarative form for their clearer comprehension.

Shaping the Body of the Discussion

Argument, once more, consists not of conversation, not of discussion merely, but of proof, and that within restricted bounds of time and space. Nothing will so insure the requirements of this economy as the outline form known as the "brief." This arrangement prevents digression, restricts discussion to the briefest possible phraseology, and insures a logicalness and continuity throughout the range of the presentation. In form, the brief is practically the same as our continuous or analytical outline so far as regards its progress through continuous sentences, and through a succession of regularly coordinated and subordinated series of heads. But here new considerations arise; every group of coordinate topics is made up of reasons—reasons supporting the belief in the truth of the statement which they follow and upon which they depend. Thus the body of the argument contains as many main captions as there are issues; and each of these leading reasons for belief or disbelief in the proposition is followed by the word "because" or "for" leading to reasons substantiating it. Each of which reasons in turn is similarly followed by its own supporting evidence. In the final form, of course, as in the case of exposition, this mechanical arrangement is departed from to some ex-

tent; but the original writing of the brief in this form insures a conciseness and a cogency not otherwise to be effected.

But argumentation implies more than the delivering of a set speech, or the writing of a formal article. The contentions of the opposition must likewise be met. This clearing away of opposing contentions is termed "rebuttal" or "refutation." Success here depends at the start upon familiarity with the subject, from every angle and every point of view; and after that, upon the ability to understand and to analyze the opposing evidence; to detect its strength and weakness at different points; and to determine at what point and with what material the counterattack may best be launched. Even where opposing evidence cannot actually be demolished, its effect can often be weakened by casual reference and indirect suggestion.

In argumentation we can scarcely overestimate the value of thus setting off the different blocks of evidence; of clearly indicating all transitions; and of recapitulating or summarizing both at intermediate points and at the end. Since argument is as a rule far more "meaty" than exposition; the mind must be relieved if attention is not to flag. Attention, indeed, must be drawn back and fixed repeatedly. An audience must be *told,* and *told* it is being told, and told *what* it has been told. Thus encouraged and stimulated to attention, it is far more likely to accord belief than where it is left to its own efforts to recollect and arrange and consider and decide.

But besides conviction, we need another element, namely, "persuasion." Just as conviction follows an intellectual process of thought, so persuasion attends the more emotional inducements to acceptance and belief. The very relationship of the audience to the subject may be made to color their decision regarding it; the character and personality of the author may win a degree of assent not altogether merited by his bare arguments; the variety of the interests appealed to, the vividness and patness of the illustrative material, and the mastery of the technique of presentation may easily contribute no small amount to determining the ultimate effect of the presentation. Thus along with intellectuality must go earnestness; and blending with the rôle of a contestant,

must appear the part of a confidential friend,—a friend who is tactful, ingratiating, trustworthy.

Ideals of Argumentation

Everything in the argument should be cumulative and climactic. The first impression in the introduction should be good; the body with its marshaling of evidence, better; and the peroration, best of all. The impression in this last, simply because of its position, becomes strong and durable. In as much as the conclusion offers the author his last best chance, he should do his best to make the most of it,—to clinch the conviction; to render indelible the emotional response. In this section should be gathered up, bound together, and brought to a head all that was either explicit or implicit in the introduction and body of the piece. Here belongs the final reiteration of belief, most succinct and most forceful; for permeating everything should be an earnestness that will admit of no indifference and brook no denial. Outstanding here should be indications of the speaker's acumen, of his probity, and assurance; of the sincerity of his belief, and of the surety of his faith in its acceptance. In MacEwan's words, the conclusion "must be brief without incompleteness, concise without obscurity, direct, forceful, compelling men to seize, hold and act upon the truth established, or to abandon the error overthrown." (*Op. cit.*, p. 262.)

One final comment. As a result of the extreme reality of many public questions involving engineering, as a result of their complexity, and the nearness with which they affect men's prejudices and pocketbooks, one does well, more particularly when one speaks or writes in a professional capacity, to be most careful of what one says. Differentiation should always be made between facts and opinions. Opinions should be reasonable; expressions of fact should be susceptible of proof, or at least should be such as can be supported by indubitable authority. A chief asset of any engineer is admittedly his professional prestige; and this must rest at one of its chief corners upon his reputation for poise and balance and judgment. Finally, let it ever be remembered that

while argument begets argument, lucid explanation begets acquiescence and belief.

Exercise.—Look up the meaning of the following terms closely related to the subject of argumentation.

1. brief, proposition, resolution, terms, issues, rebuttal, recapitulation, summary.
2. speech, address, discourse, discussion, deliberation, controversy.
3. aim, object, purpose, policy, attitude, viewpoint, position, motive, platform.
4. facts, truths, principles, opinions, beliefs, faith, judgment, theory, decision.
5. probity, sincerity, tolerance, tact, courtesy.
6. bias, prejudice, partiality, evasion, ignorance, stupidity, misunderstanding.
7. satire, irony, sarcasm, invective, censoriousness.
8. To state, affirm, allege, assert, declare, testify, advocate, predicate, propose, indicate, imply, insinuate, admit, confess, allow, concede.
9. To argue, debate, maintain, contend, dispute, quarrel, convince, refute, controvert, demonstrate, verify, prove.
10. To appeal, urge, plead, persuade, exhort, harangue, assume, infer, presume, generalize, speculate, elicit, eliminate.
11. direct, prima-facie, documentary, circumstantial, competent, material, explicit, implicit, concrete, tacit, comprehensive, consistent, concurrent, cumulative.
12. sound, credible, plausible, valid, satisfactory, trustworthy, vital, sufficient, decisive, convincing, compelling, cogent, conclusive.
13. ambiguous, conflicting, equivocal, incongruous, irrelevant, extraneous, illicit, interested, prejudicial, unwilling, reluctant, specious, sophistical, superficial, flimsy.
14. antecedent probability, begging the question, burden of proof, dilemma, fallacy, inherent probability, hypothesis, syllogism, enthymeme, induction, deduction, analogy, authority, certainty, evidence, experience, postulate, partition.
15. *a priori, a posteriori, a fortiori, post hoc ergo propter hoc, ex parte, ad hominem, non sequitur, reductio ad absurdum.*

CHAPTER XXI

HYPHENATION

This mark of punctuation, although it is most useful in its proper place, has, like many another exotic, shown a propensity to multiply in places where it does not belong. Rightly does *The King's English* [1] refer to it as a "regrettable necessity"; and general is the experience expressed by the same authors in their *Concise Oxford Dictionary* when they confess, "after trying hard at an early stage to arrive at some principle that should teach us when to separate, when to hyphen, and when to unite the parts of compound words, we had to abandon the attempt as hopeless, and welter in the prevailing chaos" (Page vi). The fact of chaos in technical hyphenation is patent to everyone who reads critically. Not only do volumes of multiple authorship show wide discrepancies in the practice of their contributors, but even within a single article we find again and again a word compounded in different ways, *red wood,* for example, alongside *red-wood* and *redwood.* Conversation with writers brings out frank acknowledgments that they are at a loss for a definite principle of hyphenation. "How," we ask, "do you write horsepower?" "Why," our friend replies, "I write it as two words—no! I should hyphenate it"—a moment's pause—then, "no, I think probably I'd write it solid." Even Webster's dictionary, an authority that has done much to improve existing conditions, reflects such seemingly inconsistent usage as we see in *rocking stone* and *rocking-chair; time lock, time-table,* and *timepiece; time ball, time-work,* and *timesaver; water tower, water-closet,* and *watershed.* Even while we admit that these spellings are all justifiable, we question whether one professional man

[1] Fowler, H. W. and F. G., *The King's English,* 2nd ed. Clarendon Press, 1908. P. 275.

in twenty would be able offhand to write them as they are given. Occasionally one hears a laughing comment on the happiness of a situation where mistake is impossible. Unfortunately, some situations are less funny than they are ridiculous. This conception, at any rate, is not in line with the ideals of engineering; and engineering should be the first to attempt to find a remedy for these conditions. This attempt, indeed, has already reached the stage of a survey. In the "Report of the Committee on Standardization of Technical Nomenclature" appointed by the Society for the Promotion of Engineering Education,[2] the differences of opinion expressed in answer to a questionnaire are characterized as "amazing." "Chaos," we read, "is the only word to describe the condition of the data; it seemed almost structureless." Such is a fair statement of the condition of things as regards this mark. The solution of the problem may lie in either one of two directions, either in eliminating the hyphen or in making the rules for it more comprehensible. The course we take should depend upon the tendencies of modern usage. Can we tell in what direction modern practice is setting. We believe we can—in the direction of marked restriction.

Suggested Solution of the Problem

George Summey quotes the exclamation of one despairing publisher, "All hyphens are a nuisance; don't put any in my work except when you divide at the end of a line." [3] John B. Opdycke advises to "use the hyphen as sparingly as you possibly can. Words outgrow hyphenation and the tendency among those who constitute the best authority is to hasten the disuse of this mark. . . . Errors of omission in its use are far less culpable than those of its overuse." [4] W. D. Orcutt bears out the same opinion when he says, "In general, hyphens should always be omitted when the meaning can be equally well expressed by using the same

[2] *Proceedings,* Vol. XXIV. P. 241.
[3] *Modern Punctuation.* Oxford University Press, 1919. P. 177.
[4] *Working Composition.* D. C. Heath & Co., Boston, 1917. P. 296.

words separately." [5] Likewise, Manly and Rickert note that "The present tendency is to avoid the hyphen as much as possible" [6]; and Manly and Powell note again that, "The modern tendency is toward omitting the hyphen in compound words and spelling them as single words." [7] In his *Suggestions to Medical Writers*, Dr. George M. Gould remarks that, "The dictionary-makers have been able to reach no uniformity in their recommendations concerning the compounding of words, and have seemed to pride themselves upon their differences. There is thus this most lamentable confusion and contradiction in the usage even of the best writers. A thousand rules are jeered at by the makers of another thousand, and everyone is left to follow the promptings of whim and caprice." But then he notes and urges that, "The trend of good English usage is to abolish the hyphen except when it is positively needed to make meaning clear." [8]

In the long run, the practice of the best writers, we believe, may be trusted to conform to the genius of the language. At the present stage, however, solution no longer lies in recording isolated preferences. Such a method would, and indeed long has been, productive of results that are illogical and inconsistent. Constantly such procedure finds warrant for divergent forms for words that are identical in structure and development. Scarcely more satisfactory are the academic, *a priori* attempts of certain dictionary makers who have legislated on the matter, and this for the reason that their rules have been too complicated and theoretical. In the face of simple newspaper standards, wiredrawn grammatical differences have little chance. The argument that the hyphen plays a useful part in distinguishing a *walking-beam* on an engine from a *walking beam* in some lumberyard fairy story, or the *running feet* of the boy from

[5] *The Writer's Desk Book.* Frederick A. Stokes Company, New York, 1912. P. 45.

[6] Manly, J. M. and Rickert, Edith, *The Writing of English.* Henry Holt and Company, New York, 1919. P. 440.

[7] Manly, J. M. and Powell, J. A., *Better Business English.* Frederick J. Drake & Co., Chicago, 1921. P. 55.

[8] Copyright, 1900, by George M. Gould, M.D.; issued by the Philadelphia Medical Publishing Company. Copyright, 1928, by Laura Stedman Gould. Pp. 48–49–50.

the *running-feet* of the sidewalk he races over, is not borne out in practice. A thousand cases would not show a single one of real ambiguity. We do not think of a *cold chisel* as one left in the icebox, or of *soft soap* as soap permitted to dissolve away in a pan of hot water. Most of the rules of college rhetorics are utterly inadequate. The age of a compound does not determine whether it should be written separate, hyphenated, or solid; and the place of the accent is a matter of slight significance. The one important fact is that compounds seek the solid form. The whole nature of English speech favors the compounding of its elements, and once started this uniting would go on to its logical conclusion. In so far as the hyphen hinders this process in true—as distinct from casual—compounds, the hyphen should be eliminated. In so far as it serves to join casual compounds, or to mark abnormality, or coordination, it finds a use and should be retained.

In all our use of hyphens we should follow lines of reason and economy. When two forms have equal authority, we should choose the simpler, confident that in the long run it will prevail. Thus to a word of three elements (horse-power), we should prefer a word of two elements (horse power) whenever authority for this is to be found, and whenever usage permits, we should doubly prefer to this again any still simpler form of but a single element (horsepower).

We now proceed to the presentation of certain groups of compounds arranged according to the relationships existing between the members, in which groups the preference of some major dictionary has been observed in enough cases to establish a certain authority for words of the several types. In the great majority of cases, the form listed is that preferred by Webster's *New International Dictionary* (1918). Although no single authority may agree on all the forms in any one group, these are all found in every instance in articles by some writer of approved standing, and together they may be taken as a fair criterion for the spelling of words identical with them in relationship. When seven of ten analogous words are written in the same way as regards the hyphen, we may reasonably hold that the inter-

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ests both of convenience and consistency are subserved by writing the other three—not in three different new ways, but in the same way in which the seven which they resemble are written.

Typical Structural Situations

Non-hyphenated Combinations

Ingredients, etc.—asphalt stone, mineral wool, tin plate; cotton waste, coal dust, copper filings; gas jet, sand blast, rock fill; wood brick, tungsten steel, ingot steel, crucible steel; carbon wool, diamond drill; cardboard; oilcloth; sandpaper; soapsuds; snowslide.

Distinctive part or feature, resemblance.—a ball and socket, a block and tackle, a plug and feathers, a rack and pinion, arc lamp, ball bearing, band saw, bead molding, box girder; needle valve; angle iron, barrel vault, belt course, bow compass, cone pulley, sleeve nut; bull pump, fish torpedo, spider frame; feather joint, gambrel roof, knee rafter; A frame, I beam, M roof, T rail; brick red, emerald green, ivory black, slate gray; bowknot; cogwheel; fanlight; hairspring; eyebolt; kneepiece; beehive; bullnose; gooseneck: hogback, turtleback.

Suggestion of operation, etc.—air brake, footh lathe, gas engine, steam whistle; compression pump, extension bolt, suction dredge; catchment area; displacement pump; escapement wheel.

Suggestion of the genetival,—possession source, etc.—crow's foot, crow's nest, bull's eye; carpenter's square, engineer's chain, molder's sand; bolt's head (= bolthead), handsbreadth (= handbreadth), cable's length; anvil block, bicycle chain, foundation wall; horsepower, candlepower, foot power, water power; beeswax, calfskin, doorcase, hillside, snowslide, snowstorm, staircase; doorpost, riverbed, windowpane, yardstick; cranesman, linesman, locksman, frontiersman, helmsman; India ink, Para rubber; field bowlders, sea water, sewer gas, storm water; corner stone, surface clay; air line, bottom plate, center rail; cross wires, overhead crane, side road; backbone, crosspiece, faceplate, riverfront, seaboard, skyline, sideboard, countershaft, crossbar, footnote, headboard, headroom, sidetrack, tailpiece. Note that *sea level* is written separate; as solid it would be seen *seal evel.*

Suggestion of adaptation, purpose, etc.—air compresser, gas generator, lightning arrestor, road grader; sand screen (er), spoke shave, stone drag, wire gage; belt punch, pipe wrench, tool post; center punch, corner chisel, range pole, stone hammer; brick kiln, coke oven, lightning rod; air chamber, fire box, steam jacket; freight car, stone boat, water cart; canal boat, day coach, street car; boiler plate, brick clay, fire clay, sewer pipe, window glass; cowcatcher, screwdriver, skyscraper, timesaver, typewriter; bricklayer; storekeeper, stonecutter, shipbuilder; guncotton, pipeclay, stovepipe, weatherboarding; gaspipe, manhole, timetable; handspike, snowplow, windbreak; ferryboat, lifeboat, tramcar; building paper, molding sand, tracing cloth; drawing knife, leveling rod, ripping chisel; connecting rod, coupling pin, driving wheel, walking beam;

milling cutter, spading harrow, traveling crane; dredging machine, drilling machine, testing machine; conning tower, mixing chamber, watering trough; footing course, retaining wall, ruling grade; drafting room, dwelling house, rolling mill, dining car; drafting board, derailing switch, moving picture; bending moment, crushing strength, living wage, working day, working strength; blister bar, clincher tire, cutter bar, roller bearing; borrow pit, catch basin, drag chain, drill press, drive wheel, slide lathe, swing drawbridge, test tube, drop forging, dump cart, set square, yield point; driftbolt (beside *drift bolt,* and so also many other words of this type, cf., hacksaw, setscrew, slipknot), blowhole, blowpipe, fishplate, stopcock.

Compounds ending with the following words take as a rule the solid form:

boat, book, house, keeper, kiln, light, load, master, maker, mason, man, plant, road, ship, smith, stone, ware, water, way, wise, work, works, wood, weight, and yard.

Such exceptions as *canal boat, stone boat, corner stone, pumice stone,* and *water works* gain little seemingly by being written separate. Compounds of *-fitter* and *-plant,* we note, are generally separate, and those in *-room* and *-shop* are ordinarily solid where the first element is a monosyllable, but otherwise separate.

Among other grammatical combinations we note those illustrated by the following words:

cross section, hot box, live load, prime mover, short circuit; backwater, blueprint, drydock, hardpan, mainspring, sidetrack, axial flow, spiral axis; circular saw, tubular boiler; asphaltic cement, elastic limit, barbed wire, compressed glass; cast iron, cut glass; bypath, byroad, byway, bywork, *cf.* by-election, by-law, by-product, -street (!). *Cf.* Compounds of after-, back-, down-, fore-, out-, over-, through-, under-, and up-.

Most verb-adverb substantives are written solid; although *Webster* hyphenates a few and *Standard* a somewhat larger number. When in doubt one does well to use the solid form:

blowoff, blowout, cavein, drawback, layout, lockout, runabout, setback, standstill, takedown, turnout, turnover, walkout, washout.

In the face of a multitude of such forms as these, the necessity for hyphenating the following is hard to understand:

frame-up, smash-up, stand-by, stop-over, take-off.

Most verb-object substantives are solid:

breakwater, catchwater, cutwater, makeweight, rendrock, stopgap; bookbinding, bookkeeping, moneymaking, waterproofing; bricklaying, fireproofing, woodworking.

We turn now to a consideration of certain forms that take hyphens. Among these we number some four or five groups of nouns, and two or three of verbs; and along with these the whole body of compound adjectival modifiers.

Hyphenated Combinations

Nouns

Noun-noun units of measure.—acre-foot, ampere-hour, foot-pound-second, horsepower-hour, second-foot.

True, noun-noun, coordinate alloys.—copper-steel, copper-zinc, iron-coper, iron-nickel, zinc-nickel, nickel-silver.

Numerals (See page 237) particularly those from 21 to 99: twenty-two, ninety-six; thirty-first, seventy-eighth.

Neutral-*o compounds.*—where these words are not properly written solid: electro-chemistry, ferro-cyanide, hydro-carbon, nitro-glycerin, turbo-generator, electroplate, hydroplane, microfarad, radioactivity, thermodynamics.

Phrasal nouns.—a step-by-step, a fore-and-after, a merry-go-round.

Verbs

Noun-verb compounds.—to air-dry, to anchor-bolt, to belt-drive, to kiln-dry, to sand-blast, to screw-thread, to water-soak.

Adjective-verb compounds.—to cold-draw, to dry-grind, to hot-roll, to quarter-saw, to red-shorten, to rough-forge, to thin-bed, to top-drain.

Adverb-verb and verb-verb compounds.—to back-fire (backfire, cf., backfill), close-bolt, cross-plow; to prick-punch, to drop-forge, to shunt-wind; to overbalance, to overcapitalize, to overexpose, to underdrain, to undervalue; to backfurrow, to crosscut, to cross-hatch, to safeguard, to sidetrack, to whitewash.

Adjectives

Probably the chief service rendered by the hyphen is to link together the parts of compound adjectives so as to make evident their singleness of conception. Independent modifiers, of course, are not hyphenated:

ashless filter paper, light turning tools, ornamental magnetic arc lamps.

Again hyphens are not used between an adverb in *-ly* and an adjectival or participial modifier of a noun:

> slightly muddy water, heavily traveled roads, swiftly flowing current, newly laid surface.

The more ordinary adjectival combinations, whose singleness of signification is brought out by the hyphen, appear in the examples listed below:

> India-rubber ball; bird's-eye maple, turtle-back deck, squirrel-cage motor, clover-leaf cam, figure-four trap; August-October accounts, Boston-Worcester turnpike; Anderson-Evans bucket (Cf., Kaiser Wilhelm Canal, the Connecticut Avenue arch), rock-asphalt paving, ankle-deep mud, breast-high wall, fire-safe roof, water-soluble salts; cherry-red heat, coal-black ink, ivory-white porcelain; ball-like, bell-like, shell-like (and other compounds ending in *l;* most others are written solid: chalklike, knifelike, workmanlike); burglar-proof (Most compounds of proof, especially those with monosyllabic nouns are solid.); air-tight, fluid-tight, water-tight; butter-colored, slate-colored; egg-shaped, fan-shaped; rope-laid cable, roller-bearing axle; air-cooled floor, cable-laid rope; stem-winding gear, water-bearing sand; a lip-pour ladle; building-up process, marking-out machine; alternate-shovel method, four-cylinder car; ten-cent rate, 30-hp. motor; bluish-gray tone, whity-brown substance; bold-faced type, hard-baked tiles; indoor work, offshore wind (and so practically all adverb-noun modifiers); ever-ready attitude, extra-hard metal; north-northeast wind, well-off company; above-mentioned terms, far-reaching effects; broken-stone macadam, varying-speed motor; broken-down arches, tied-up tonnage; called-for values, unmade-up material, uncared-for property, unheard-of demands; hurry-up job, throw-out gear, tumble-down place; ball-and-socket joint, chain-and-bucket dredge; fore-and-aft sails, hard-and-fast rule; in-and-out courses, to-and-fro motion; cut-and-dried method, cut-and-try process; hit-or-miss system; horse-drawn-vehicle traffic, wire-cut-lug brick; long-drawn-out job, half-filled-in framework; day-by-day advance, run-of-kiln brick; one-against-two masonry, two-to-one proportions; heavier-than-air machines, dry-as-dust material; out-of-door work; out-of-true line; made-in-Germany substitutes; go-as-you-please rate; hard-to-come-at corners; happy-go-lucky fashion.

We should note that the hyphen is not used to separate certain abbreviations, combinations of abbreviations, or signs, when these are conjoined with numerals, trade names, proper names, and the like, as illustrated in the following expressions:

> *per cent* drop; a 10-*per cent* saving; a 10% saving; bulbs of 10-cc. to 15-cc. capacity; a 60° angle, Cf. a 60-deg. angle; a *No. 3* pipe, Cf. a number-one glass; a *No. 9*-gage wire; a type-*8 A* transformer; twelve *12* × *12* × *8*-in. hollow tiles; *1:2* portland-cement mortar;

a 19-*in.* × *30*-in. case; a *D. C.* 4-panel switchboard; a "*W C*" Corliss air machine; a *Brown* and *Sharpe* gage; the *Watertown Arsenal* rail-joint test; the *United States* gallon

Special Cases

The Suspension Hyphen

In cases where the second member of two or more compound modifiers appears only on the last of the series, the question arises whether the hyphen should be retained by the first member or members after the ellipsis. George Summey in his *Modern Punctuation* gives the example "*out of eye- and ear-shot of the master*" (p. 135); but later on page 177 observes that "the hyphen is usually a nuisance in suspended expressions like *ten- or twenty-dollar notes.*" Little reason, indeed, can be found for using the hyphen in such simple expressions as *eight and ten-story office buildings, four by six-inch lumber, 2 by 2 by 4-inch scantling,* or *wide and narrow-gage railroads.* When, however, the series is long and suggests no evident formula, the hyphen may facilitate the immediate understanding of the nature of the series; thus, *Inquire about our 26-, 28-, 32-, 36-, 38-, and 42-inch lathes;* or, *the mono-, di-, and tri-nitro derivatives of benzine.* In case one or both of the adjectival members are hyphened, the hyphen after the first looks excessive; as in *check, blow-off, or Y-type valves,* or in *the hot-bulb or so-called semi-Diesel-type engine.*

Sometimes the two compound adjectives refer to one and the same object. In such cases the whole modifying expression should be united. Thus, floats cushioned one by air and another by water would be referred to as *air and water-cushioned floats;* but if a single float were cushioned by both air and water, it would be an *air-and-water-cushioned float.* In like fashion, separate devices to give warning of changes in water levels would be *high and low-water alarms;* whereas a single device serving both purposes would be *a high-and-low-water alarm.* In such expressions as the following no further hyphens are required:

a more or less meandering course
an orange-peel dredging and excavating bucket
twenty-seven vertical and two inclined 12-in. by 12-in. timbers.

Prefixes

Of the forty-six common prefixes in the following list, thirty are almost always joined immediately to the word they limit, save for exceptions noted in the two paragraphs below. To these thirty may be added *ex-* and *re-*, which take the hyphen only under special and specific circumstances; also, *mid-* and *off-*, for whose few hyphenated forms other well-authorized solid variants exist. In the case of *off-*, however, as also in that of *after-*, *cross-*, and *extra-*, the case is complicated by reason of the fact that the prefixed may be confused with independent words functioning as one or another of the several parts of speech. Eight prefixes remain, all of which may be said more generally than not to take the hyphen: *all-*, *by-* (or, solid), *half-*, *non-* (save in *Webster*), *quarter-*, *quasi-*, and *self-*, *vice-* (save in *Webster*). We note that a desire to emphasize the meaning in the prefix justifies the use of a hyphen where regularly it would not occur.

Solid aero, ante, anti, auto, bi, circum, counter, electro, (ex), extra, hydro, infra, inter, micro, (mid), (off), out, over, pan, post, pre, pro, pseudo, (re), semi, sub, sulpho, supra, thermo, trans, tri, ultra, un, under.

Special exceptions
ex, ex- (in sense of "former"), re, re- (in sense of "to once more——").

General exceptions
after, after-; cross, cross-; extra, extra-; off, off-.

Hyphenated
all-, by-, half-, (non)-, quarter-, quasi-, self-, vice-.

Certain exceptions in the case of words written solid must be noted. The first concerns prefixes ending in a vowel (*a, e, i, o*) preceding words beginning with a vowel. When the two letters thus brought together are *a's*, the hyphen is usual:

extra-atmospheric *C S W*,[8] infra-axillary *C S W*, supra-auricular *C S W*, ultra-atomic *S W*.

[8] *C* = Century; *O* = Oxford; *S* = Standard; *W* = Webster.

Likewise, between *a* and a following *e*, *i*, or *o;* also between *o* and *i*, some authorities insert a hyphen, although the form without the hyphen would appear sufficient:

extra-essential *C W S*, supra-ocular *C W*, ultra-intellectual *C. W*, auto-infection *W*, ultra-equinoctial *S*, supraocular *S*, ultraintellectual *S*, autoinfection *S*.

When two *e's* or two *o's* are brought together, one has a three-fold choice, namely, to write the word with the hyphen, with the diaresis over the second letter of the pair, or solid. Of the three the solid form is simplest and usually sufficient:

preëlection *C W*, preënact *C W*, preëngage *W*, preëxamine *C W;* preelection *S*, preenact *S*, preexamine *S;* electro-optics *C S*, electroöptics *W*, cooperate *S*, hydro-oxygen *W*, coördinate *C W*, coordinate *S*.

Note.—after *auto-*, *pseudo-*, and *sulpho-*, a fourth possibility is found in the supression of the *o* of *ant[o]oxidize*, Cf. *pseud[o]onymous*, *sulph[o]oxide*.

When in adding a prefix two *i's* are brought together, they may be either hyphenated or written solid:

semi-incandescence *W*, semi-independence *C W*, tri-iodide *S*, semiincandescence *S*, semiindependence *S*, triiodide *W*.

To insert a hyphen between like consonants (*out-travel C*, *post-treaty S W*, *sub-basement S W*) is unnecessary, since in numberless cases like letters unite without hyphen:

circummigration *S*, midday *C S W*, outtravel *S W*, overreach *S W*, subbase *C S* (subbasement *C*), transship *C S W* (tranship).

When, as often happens, prefixes are added to proper nouns or adjectives, they may take a number of forms accordingly as their function is adjectival in the simplest, most general sense, or as they denote specifically particular movements, parties, governments, periods, or the like. In the most usual form, the prefix is added with a hyphen to the capitalized word:

ante-Norman *S*, anti-British *S*, ex-President, inter-Asiatic, mid-Atlantic, mid-August *O*, non-Euclidian, to out-Herod *O*, post-Renaissance *S*, pre-Columbian *S W*, Pro-Boer *O*, pseudo-Gothic *O*, semi-Euclidian *S*, sub-Pyrenean *S*, trans-Siberian *S W*, un-American *W*.

In the case of *ex-*, the second initial is reduced to a small letter if the title would not itself call for a capital; as, *ex-mayor, ex-commissioner.* Save in the case of *trans-Siberian,* where the two *s's* are responsible for the hyphen, *trans* is regularly united immediately to the word it follows with a reduction of the capital:

transafrican *S*, transalpine, transatlantic *S W*, transappalachian *S W*, transcaspean *S W*, transcaucasian *S O*, transtiberine *S*, transvaal *S W*.

Syllabic Division at Line Ends

The division of a word at the end of a line of manuscript is, wherever possible, to be avoided. So also is the division of monosyllables or short dissyllables, or the setting off of one or two letters either at the beginning or end of any word, or the breaking of words at the end of a number of successive lines. Especially is the division of dates, figures, abbreviations, symbols, proper names, and hyphenated words (save at the hyphen) to be avoided, or any division which would suggest anything other than the proper pronunciation of a word. All diphthongs (re*oi*l, b*ou*gh, etc.) and tripthongs (ad*ieu*, b*eau*, etc), and all digraphs (gra*ph*ic, ma*ch*ine) and trigraphs (ca*tch*ment, *sch*ism) are to be treated as single letters and kept together. The following rules cover most of the cases that are likely to occur:

1. Divide between the parts of a simple, obvious compound: *length-wise, passage-way.*

2. Divide between a prefix or a suffix and the word to which it is attached: *inter-section, standard-ized.*

Note.—A consonant added to another consonant because of a suffix belongs with the suffix: *equip-ping, occur-rence, control-ler.*

3. Divide between two consonants when they are sounded in different syllables: *com-bus-tion, dis-satis-fac-tion, dimen-sion.*

4. Divide three or more consonants according to the pronunciation: *ag-gregate, concen-trate.*

5. Divide between vowels that are sounded separately: *a-erial, flu-idity, vari-ation.*

6. Divide before consonants not preceded by a *short accented* vowel: *bri-quettes, cu-mu-la-tion, vi-bra-tion.*

7. Divide after a consonant preceded by a short accented vowel: *capac-ity, min-imum, sep-arate, spher-ical approx-imate.*

8. Do not join *l, n,* and *v* to a following *i* when the latter has the sound of *y: pecul-iar, len-ient, behav-ior.*

9. Do not separate *r* from a preceding short *a* or *e: angular-ity, per-manence.*

The Course of Practical Sufficiency

The person who observes in his writing the large principles illustrated in these examples will in his composition not deviate far from the course of the best practice. Where in the main he follows the rule, his occasional conscious deviation will gain in effectiveness.

Exercise 1.—Write out the following expressions correctly, in the solid, separate, or hyphenated form, as they require.

1. wood working, under current, a powerful clear white light, a water cart, sulpho carbonate, a bottom pour ladle, the built up truck of a 100 ton cast steel hopper car

2. north by east, a self starter, a 42 in. woven wire fence, passers by, semi detached, a brass bound mahogany rule, a new 48 in. Niles heavy car wheel lathe

3. a stop gap, self centering, a cast brass water jacket, a run away accident, quasi public, a 4 duct clay conduit, a tandem compound rolling mill engine

4. a fire escape, semi anthracite, fast light delivery trucks, a turn over, quarter sawed, a No. 2 B Universal turret lathe, a 28 in. 8 ply Rexall double stitched conveyor belt

5. a lock out; self centering, an automatic double throw switch, the water level, an over charge, a sixty dollar a month wage, a new handy quick operating metal cutter

6. an off set, a non conductor, a chain and bucket pump, a belt line, a micro phone, the Siemens Martin steel process, a single engine driven 500 kw. electric generator

7. brick laying, half lengths, a tall steel skeleton office building, a hand car, over production, bolted steel side pieces, between extreme high and extreme low water levels

8. a hole in the air, ex president, present day motor truck design, a cut water, a non resident, a wooden box factory, a new economical high temperature fire brick cement

9. a prime mover, electro engraving, 5/8 in. steel cables, a run about, hydro oxygen, horse drawn vehicle traffic, a No. 3 Brown and Sharpe 3/28 in. spur gear cutter

11. a power hammer, half pay, a bluish silver white metal, a walk out, electro motive, a 15% storm water run off, bulks of 10 cc. to 15 cc. capacity

12. up thrust, cross references, 40 and 65 per cent increase, stop over privileges, a micro volt, the twenty first series, semi floating worm drive motor truck axles

13. a wash out, a counter check, many colored brick, an out building, a cross section, a fine cutting edge, a three fourths inch flat head bright screw

14. a spot light, auto truck, a standard sixty six foot road, a drag line, out distance, water cooled gas engine cylinder, the low water level of Lake Michigan.

15. pick and shovel work, two wheel barrows, a 12 in. by 31½ in. I beam, nitro glycerin, dry pressed brick, a storm water run off, to heat treat, zinc nickel, a horse power hour, between a 40 and a 60 degree temperature

Exercise 2.—Indicate the syllabic division of the following words:

1. admission, advertisement, accommodate
2. acknowledgment, assistant, balance
3. capacity, concession, conspicuous
4. connection, correspondence, embarrassment
5. detonate, fulminate, inaccessible
6. inexhaustible, influence, inseparable
7. mechanism, methodical, miscellaneous
8. metallic, necessary, negotiable
9. practical, relinquish, separate
10. rarefaction, periodic, convenient.

CHAPTER XXII

THE ENGINEERING-PROJECT TALK

Often and again we have been told that truth is stranger than fiction. One of the surprising things in the field of modern story-telling is the scarcity there of engineering subjects. A possible explanation might perhaps be found in the fact that story-writers know little of engineering; and that most engineers find reality infinitely more fascinating than any story. Before the intrusion of the feminine element that marked the advent of Arthurian romances, the world had listened to tales of masculine accomplishment in the *chansons de geste,* or "songs of deeds." How many triumphs of modern engineering—the seventy times seventy wonders of the modern world, invite the minstrel voice, and would well reward any worthy bard! But lacking singers, these deeds must be celebrated in prose. Not, however, the prose of exposition, for their spirit is still the spirit of romance. The sterner virtues of technical writing must here at least be touched with picturesqueness, with the glamour of accomplishment.

The Parts of a Project Paper

An introduction, body, and conclusion we may by this time take for granted. The first of these divisions may refer to whatever fact or feature may lend present interest to the project being presented. It will tell us just what it is and where it is located; what specific aim and object lay back of its design; what problems it presented; and how their solution was effected. But before construction comes the story of promotion, the sense of growing need, and the urging of the necessity of improvement. Agitation may have

been necessary, legislation possibly, financing inevitably. All these things become an essential part of the story of the project; they may well be followed by a brief indication of the main technical aspects of the work as these are to appear in the body of the article. The entire effect of the introduction may, to advantage, approximate the preliminary summarizing paragraph of a news story.

The body, dealing with the project itself, must be organic in its arrangement. But to say this is not to stipulate that any particular sequence must perforce be followed. Its point of view may be narrative or it may be descriptive; that is, it may go on to tell how the work was done, or it may set forth the results of the work either as wholes or in details. This first, or chronological, method will "log" the steps of the enterprise; the second, or pictorial-expository method, will go from part to part explaining the structural features. In either case the advance must be through large divisions that themselves are blocked out into main sections and subsections.

Naturally in the story form these major divisions would coincide with the main stages of the operation, with the difficulties encountered, and the problems successively brought to solution. Preliminary work would be followed by actual construction. A part of the former would be at the location of the project, and another part would be office work. In the first instance would come the survey or reconnaissance, and then the practical provisions for the undertaking. The investigating of conditions natural and economic,—the climate, the topography, the geological formation; in remote regions, the preparing to meet requirements of transportation and labor supply; in congested districts, providing against interference with the rights and convenience of other enterprises. While these things were being attended to at the site, the office force would be occupied with the design; with determining its requirements technical and financial; and with working out a plan that would satisfy these requirements. The special features of this plan, its peculiar adaptability, and its superiority to other types of design—more particularly any unique features that may be embodied in it,—are likely to be touched upon in the con-

sideration of this part of the enterprise. Then comes the organization of the working force and the actual process of construction. We shall not attempt to follow this sequence of operations, for in this particular, naturally, papers differ most widely; but here, in the heart of the composition, the order should be most obvious. The main operations should be set off from such as are incidental or auxiliary; and, along with other general statistics of times and costs, presented by themselves. This section should show the main structure growing through its naturally successive phases, and rising gradually and proportionally to completion.

The conclusion may comment on the achievement, on its significance and value. It may call attention to any outstanding engineering features of design or procedure, to any unusual use of materials, or to any devices that made for expediteness or economy. It may also point out the value of the project to the immediate present and to the more distant future. It may compare the project with others of its kind, both in magnitude and in benefits. Finally, it will in many an instance come at the close to a collection of notes on the financing of the enterprise; the time occupied in carrying it out; and the officials, engineers, and contractors who had the work in charge.

The Marvels of Engineering

Who can recount all the wonders of this age—its building of cities, and filling them with monumental structures; its mighty thoroughfares by land and air and sea; its skyscrapers and power plants, its railroad terminals and university and municipal stadiums; its flood control and irrigation projects; its magnificent bridges of every kind over streams and harbors and high canyon-like abysses; its mysterious tunnels and aqueducts carrying water and traffic, under cities and mountains, beneath broad rivers and wide arms of the sea; its marvelous provision for heating and lighting these cities it has built, and for filling them with power unmeasured to serve their every need and every convenience; its production and transmission and distribution of this energy, not only in the cities themselves but over the

whole face of the country round about; its all but impious plans to tap the central fires of the earth for heat and energy to serve its use. These enterprises, the every-day work of the world, seen in the right perspective, are englamoured with romance. A proper subject, surely, with which to bring our course to its conclusion.

CHAPTER XXIII

THE THOUGHT PAPER

Preliminary considerations.
- Gathering material.
- Digesting material.

Structure and movement.
- Organizing the thought.
  - In the body.
  - In the other divisions.
- Organizing the cadences.
  - To suit the several divisions.
  - To satisfy quadral requirements.

Structure a universal element.

How shall we put together a thought outline—the material for which is to come, mainly, not from investigation but from our own ideas? If order is desired, we would suggest the following procedure. Let us say that we are going to speak on "engineering as a profession." Our first task, of course, is to gather our material. So, for a fortnight we carry the subject around with us—think on it as we go to sleep, and on waking glean our minds. All our ideas we jot down, and ideas will come from sources most unforeseen. Then we make occasion to put in a few hours in the library, looking up the terms "profession" and "engineering" in all the dictionaries and encyclopedias, and glancing through a few articles suggested to us by the *Reader's Guide.* Now we are ready to arrange our outline.

Structure and Movement

Can order be hoped for out of such a promiscuous conglomeration as is represented by our notes—fragmentary ideas, real and suspected. But as we look them over, cer-

tain ideas begin to shape themselves amid the confusion. That of "professionalism," for instance, as distinct from the "professions"; the differentiation of the two; the greatly increasing number of the so-called professions; the professions as a field of opportunity; professional ideals; the training of a professional man; the attitude of the public toward the professions; the grounds for classifying engineering as a profession. In a word, our chaos begins to show ideational floccula, at least; and encouraged by this we once more go over the material in search of some twofold divisions for the body of the article. Tentatively, we hit on the following as inclusive of most of our conceptions:

1. The professions.	2. Professionalism.
1. The professions—what they are.	2. What they give.
1. Professional ideals.	2. Professional practice.
1. The professions—in the concrete.	2. In the abstract.

These we consider from all angles; and decide finally on the last pair, re-phrasing them however, so that they read "The Professions" and "Professionality." These give us our main heads A and B. From them we proceed as before, securing under A, as I, "Their simple past," and as II, "Their complex present"; and under B, as III, "Professional preparation," and as IV, "Professional practice." Now we distribute our notes into these four cardinal piles. So we continue until our outline is complete—eliminating duplicates, weighing phraseologies, studying logical relationships, attending to rhetorical effectiveness. By holding throughout to a twofold division we insure a certain balance and symmetry of design; and furthermore, as the thing is to be spoken, greatly facilitate its memorizing. This last desideratum is further effected by verbal similarity in coordinate headings. In the end the outline of the body takes some such shape as the following:

The Professions:

Their simple past:

Religious origin.
Secular development:

The citizen in his private capacity,
- Labor.
- Trade.

The citizen in his public or "professional" capacity,
- Military aspect.
- Civilian aspect.
  - Theology, medicine, law (Their common elements; scholastic preparation; and consultative capacity,—both of these prominently featured in a definition of a profession handed down by the Supreme Court; "a vocation involving relations to the affairs of others of such nature as to require for its proper conduct an equipment of learning or skill, or both, and to warrant the community in making restrictions in respect to its exercise."—*Annals* of the American Academy of Political and Social Science, Philadelphia, Pa., May, 1922, Vol. CI, No. 190, p. 18.)

Their complex present:

Division of the old, aristocratic, "learned" professions, resulting from independent thought and scientific research:

Humanitarian branches,
- Theology.
- Medicine.

Civil branches,
- Law.
- Military science.

Multiplication of new, democratic, "vocationally trained" "professions," resulting from a desire for titles and preferments and perquisites long denied the commonalty:

Technical skill,
- E.g., Horology,
  Fine arts.

Commercial pursuits,
- Business.
- Industry.

Commercialized entertainment,
- E.g., Acting.
  Athletics.
  - (The recognition by nineteenth-century writers of the individualized, competitive aspect of these latter branches as compared with the larger, more social, and more cooperative aspect of the former.)

Professionality:
  Professional preparation:
    Education:
      Looking to a thorough mastery,
        Of a group of basic sciences.
        Of a group of specialized, related sciences.

      Looking to an efficient command,
        Of the machinery of performance.
        Of the technique of expression.

    Orientation:
      Looking to an articulating with allied professions,
        Such as law.
        Such as economics.

      Looking to an understanding of the society to be served,
        Such as the individual or the corporation.
        Such as the municipality or the state.

  Professional practice:
    A realization of public trust:
      Seeing self as a repository of social lore hard earned, and priceless.
      Seeing self as a responsible agent of the client or of the social group.

    A reverence for professional tradition:
      Seeing in it an inheritance to be prized and perpetuated.
      Seeing in it a body of principles to be perfected and put into practice.

With the body of our article thus disposed of, we turn our attention to the introduction and the conclusion. The latter we shall make a summary, working in as best we can material on "the nature and the wages of the professions." This section quickly shapes itself into the following outline:

Criteria of the professions
  What they are not
  What they are

Wages of the professions
  What they are not
  What they are

And finally, we add to these, as a sort of epilogue to our conclusion:

Standards of professionality
- The character of these standards
- The maintenance of these standards

Prerequisites of professionality
- Engineering as a profession
- The engineer as a professional man.

Still remains the Introduction, into which we can work a promiscuity of odds and ends. These will serve to focus attention and awaken interest in the matter to be discussed. Still, in all our seeming inconsecutiveness must appear a strain of continuity. All that we say must shape itself inevitably toward something. To serve our purposes in this loose division, we may take as topics,

The professions—Undefined!
The professions—Definable?

Now, all that we need is a Title; one that is short, and one that is cadenced. The former quality requires no explanation; the latter will be found to be present wherever the scansional pattern of stress and unstress, is either repetitious (i.e., ᴗ—ᴗ—; ᴗᴗ—ᴗᴗ—;—ᴗᴗ—ᴗᴗ, etc.) or symmetrical (i.e., ᴗ—ᴗᴗ—ᴗ; ᴗᴗ—ᴗᴗ; etc.), allowing in the latter one extra weak terminal syllable (ᴗᴗ—ᴗ—ᴗ; ᴗ—ᴗᴗᴗ—ᴗ).

Such titles we find, in phrases like the following:

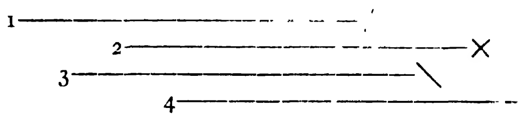
Professional Spirit
ᴗ — ᴗ ᴗ — ᴗ
The Professional Attitude
ᴗ ᴗ — ᴗ ᴗ — ᴗ ᴗ
Professional Engineering.
ᴗ — ᴗ ᴗ ᴗ ᴗ — ᴗ

Of these perhaps the first will serve us as well as any; possibly with the addition of a "The."

Organizing the Cadences

If we take the style of the Body as the norm, that of the Introduction will be found to be a little shorter, a little

more staccato; and that of the conclusion to be a trifle longer and more sequacious in its movement. To suggest something of the effect of these differences, and at the same time to illustrate the method of amplification, we shall venture to write out completely our introduction and our conclusion. Moreover, to indicate clearly the natural "quadral" divisions of discourse, by which the mind is wont to move ambulatory fashion as does the body—to the left and to the right, then to the left and to the right again, we shall set apart these natural rhythmal advances by the use of the following marks:



The great proportion of the phrases that make up the quadral lines should, by the way, show the scansional patterns mentioned just above in our speaking of the title. (See the author's *Rhythmic Prose*. University of Iowa "Humanistic Studies," Vol. III, No. 1.)

Introduction

A recent story / in The *Saturday Evening Post* × introduced a new profession" \—"gate-crashing | ." This gate-crashing /, I assume you know × , is dead-heading one's self \ into public entertainments | . The ranks of the professions / are beyond a doubt × rapidly \ filling up | . Who can tell us / any more × who is a professional man \ and who is not | . Some one remarked / the other day × , that the "profession \" of boot-blacking | must be *almost* / as lucrative now-a-days × as that \ of boot-legging | . And if *his* boot-black / is accounted a professional × , so also \, is *my* barber | . Where, we ask /, shall we draw the line × , or better \, can any line be drawn |, that will separate / the professions × from such callings \ as are non-professional | ?

In a word /, is "profession" definable × ? how can we use it \ in classification | ? Are teachers / professionals × ? are aviators \ , or window dressers | ? are chiropractors /, or contractors × ? are public accountants \, or engineers | ? Shall we allow / that the number of professions × is forty \, or four hundred | ? And how shall we distinguish / professionalism × from what we know \ as professionality | ? In our attempt / to answer these questions × we shall speak briefly \ first of the professions |, and then say something / of that spirit of devotion × by which the professions \ are assumed to be actuated | .

Conclusion

Have we made plain / these outstanding criteria × which guard the gates \ of every profession | ? Skill / ? cleverness × ? special knowledge \ ? Not these alone | ! The badge of some organization / alleged to be professional × ? a salary, may we say, \ of five |, or twenty |, or fifty-thousand dollars | ? a firm grasp / on some tremendous lever arm × political \ or industrial | ? Again / we answer ×, not these \, or these alone |. Rather it is found / in that high spirit × that believes something \, that professes something |. Believes / that the whole × is ever greater \ than its parts | ; professes / its own preparation × to serve this whole \ even as it serves itself |. We find it in a spirit / that in its works × proves its entitlement \ to the public confidence |. And supplementing / these practical considerations ×, we find it in a character \ and a personality | ; we find it, in short, / in a life × that sets new standards \ of civilian service |, and affords / new patterns × for professional \ emulation |. Getting /, and giving × ,—each \ has its reward | ; the spirit / that makes the public pay × and the spirit \ whose motto is *noblesse oblige* |.

The wages / of the true professions × are quite different \ from those of professionalism |. They are not / publicity × ; they are not primarily \ pecuniary gain |. Their rewards / are found in affiliation × with those who are doing \ the world's great work | ; in a consciousness / of lasting accomplishment ×, in a sense of contribution \ to perpetual memorials | ; they live in the approval / of one's peers and associates ×, and finally \, of one's self | ; they rise / in the appreciation ×, in the deference × in the recognition ×, of society \ at large |.

"The prettier / the kind of a thing is ×, the more desirable it is \ that it should be pretty of its kind |." Thus delightfully / has Charles Lamb × expressed to us \ a significant truth | ;—the more excellent / the sort ×, the greater the insistence \ upon excellence |. And just to the extent / that every real profession × is deep \ and significant |, a duty devolves / on its each and every member × to bend his efforts \ to maintaining this excellence |, —to guarding / against any lowering × of its standards \ and its requirements |. Democratization / we welcome × ; but only to the extent \ that its leveling be upward |.

Regarding Engineering / this dearest child × of this most wonderful \ of all the centuries |, we need not ask / whether or not × its *spirit* \ be professional |. It is the breeder / of seers ×, of inspired "makers \," of the poets of actuality | ,—of those whose minds / are first envisaging × tomorrow's \ habitations |. "But let us take," you ask /, "*this* engineer × ; is he \ a professional | ?" "Does he *belong* /," we answer ×, "to the 'profession \' of engineering | ? Has he given himself / to it × heart \ and soul | ? Is he, that is /, such a man as this profession × or any profession \ can rightly own | ? Is he, in short /, a *professor* of something ×, and one who *lives allegiance* \ to all that he *professes* | ?"

Note that in these quadrals each advance is likely to show a point of potential division; thus it is possible for us to read the last sentence:

Is he / in short ×, a professor \ of something |, and one / who lives allegiance × to all \ that he professes |.

STRUCTURE OF A UNIVERSAL ELEMENT

Composition is composition. Whether its object be utile or artistic, its basic law is still the same. All artistic forms of expression,—graphic, plastic, or architectural, inarticulate music, articulate song or prose, demand alike for their perfection orderliness and regularity. So here with our thought paper we must first and last have structure. Underlying its seeming informality must be something structural, organic, vertebrate, no less than in the severest exposition. The thought must be regularized; so also, the very words and syllables. Only so will "the music of language" answer to "the music of the mind."

But this is a "thought" paper. Our ideal is to show *thought* alone,—to make the thought conceal the words. The medium in perfect expression is always wont to disappear: the higher the verbal conductivity, the less obvious the verbal element. To achieve this effect is our problem; —let us *do* what we do.

Note.—What we have termed a "paper" may either be read, or delivered orally without manuscript. The outline here presented served once as the basis of a sixteen-minute talk at a Mecca Day banquet.

CHAPTER XXIV

THE ENGINEERING VOCABULARY

The English vocabulary is in its sources complex, composite, conglomerate, heterogeneous, to a degree almost unbelievable. It contains elements from not only all the European languages but from the ends of the earth. The supplementing of the original Anglo-Saxon stock has been going on for the period of at least fifteen hundred years. The result of all this borrowing is in a broad way a bipartite language; on the one side native and northern elements, Teutonic and Scandinavian; and on the other, the so-called classical elements,—first, Greek and Latin, and then the modern Roman-ce elements, French, Italian, and Spanish. If we think of the technical vocabulary as being nearly three quarters classical and one quarter native and northern; and then of this classical vocabulary itself as being about three quarters Latin and one quarter Greek, we shall not go far wrong in our idea of its general constitution. Of its northern words something under three quarters are of Anglo-Saxon derivation; and of the southern words something over three quarters have come to us with forms variously modified from the original as a result of intermediate stages of development in some medieval or modern language. The Latin and Greek words show a certain common quality, being abstract, abstruse, polysyllabic, severely technical, and obviously professional. Similarly, the northern words bear to each other a strong family resemblance. They are alike short and concrete, with the Scandinavian and Dutch words among them only a little more suggestive of the northern ocean, the London wharves, and the mills of Ypres.

We can express ourselves in language that is almost pure Anglo-Saxon, as Shakespeare has done in the following passage, wherein 49 of the 50 words are of this origin:

> Neither a borrower nor a lender be;
> For loan oft loses both itself and friend,
> And borrowing dulls the edge of husbandry.
> This above all: To thine own self be true,
> And it must follow, as the night the day,
> Thou can'st not then be false to any man.
> Farewell! —*Hamlet,* I, iii, 75–81;

or as Oliver Wendell Holmes has done in this other passage where only 4 words of 102 are of classical derivation:

> "Let us get up and see what is going on.—Oh,—oh,—oh! do you know what has got hold of you? It is the great red dragon that is born of the little red eggs we call sparks, with his hundred blowing red manes, and his multitudinous red eyes glaring at every crack and key-hole, and his countless red tongues lapping the beams he is going to crunch presently, and his hot breath warping the panels and cracking the glass and making old timber sweat that had forgotten it was ever alive with sap."
>
> —*The Professor at the Breakfast Table.*

Because of the fact that our articles, conjunctions, prepositions, pronouns, adverbs and common verbs of being are so generally Anglo-Saxon, we cannot express ourselves altogether in classical derivatives. We can, however, write sentences whose important words are almost without exception of Greek and Latin origin, as appears in the following passages adapted from technical articles:

> "For *regulating current rheostats employing vertical electrodes* are *preferable* to *rheostats using horizontal electrodes, because* by *immediately releasing gases formed* they *avoid polarization* of the *plates;*

and again,

> "The *actual apparatus,* like *products* of *genius generally,* is *extremely simple, possessing* in *compact form elements* of *portability, flexibility,* and *control requisite* to the *purpose intended; i.e.,* at the *transmitting station,* a *source* of *electricity*—an *accumulator,* a *coil, controls,* a *selective device,* a wave *transformer* and *transmitter.*"

As representative of the several elements in our vocabulary, we may take the following:

Anglo-Saxon.—adz, ax, ball, batch, beam, beat, bench, bend, blade, blast, bolt, break, bridge, burn, chip, clay, clean, cleat, coke,

cold, crack, crane, crank, crib, dam, deep, dig, dike, ditch, door, draft, drain, drive, dry, dust, anvil, axle, blister, cinder, clevis, elbow, empty, fasten, girder, highway.

Scandinavian.—bag, bilge, brink, bulk, cake, cast, clutch, dash, drag, dump, flat, flaw, floe, fog, gap, grab, keg, kink, leak, link, loft, muck, raft, raise, sag, scant, scoop, scorch, scrape, skid, skill, slant, slot, squall, stack, slump, swamp, swash, train, weld, whirl, bowlder, bowsprit, bunker, clumsy, eddy, geyser, skewer, tungsten.

Dutch.—berm, block, bluff, boom, boss, brick, clamp, creek, cruise, cure, deck, dock, dredge, drill, drum, freight, groove, hoist, hold, hook, hull, lash, leak, lump, nick, notch, patch, plug, rack, rail, scow, screen, shock, silt, skew, skiff, sketch, sled, slight, sloop, snap, splice, spool, squirt, stoke, strand, stripe, swab, switch, tramp, track, tub, dug, wreck, yacht, ballast, border, caboose, clinker, firkin, litmus, placard, slender, spelter, splinter, tack, trigger, wainscot.

German.—bismuth, cobalt, felstone, gneiss, loess, spray, quartz, shale, slack, zink, spiegeleisen.

Celtic.—bag, brogan, cradle, flannel, gaff, gain, goggles, job, lag, loop, racket, rub, shanty, skip.

As illustrating classical words that have kept a close approximation to the original forms, and also those that have suffered various alterations during later centuries, we may take:

Greek.—chart, erg, graph, schist, acme, bromine, cathode, colloid, cyanide, echo, ethane, graphite, helix, hydrant, ion, ketone, naphtha, oxide, aerial, anion, anthracite, ballistic, diaphragm, dynamics, dynamite, dynamo, electrode, electrolyte, entropy, helium, adiabatic, allotropy, automatic, bacterium, clinometer, hysteresis, icosahedron, kilometer, kinematic, mathematics, microtome, microscope, phosphorus, photograph, polyphase, pyrometer, rheostat.

Greek→Latin.—axiom, basis, box, bulb, catalysis, cataract, catastrophe, creosote, deleterious, diameter, dish, disk, geology, geometry, heterogeneous, hexagon, hydrogen, hyperbola, inch, logarithm.

Greek→Latin→Romance.—air, amalgam, architect, arithmetic, asbestos, astronomy, atmosphere, atom, bomb, brace, canvas, cartridge, climate, cone, cornice, crystal, cycle, cylinder, diagram, dome, dram, eccentric.

Greek→Romance.—caustic, characteristic, emery, metacenter, millegram, millemeter, oxygen, parallax.

Latin—abrupt, agent, algae, axis, construct, contact, contract, corrode, credit, datum, degree, dial, duplex, exhaust, abscissa, absorption, accurate, adequate, adjacent, aggregate, agitate, alumina, antenna, approximate, bacillus, bitumen, accelerate, accessory, annunciator, apparatus, artificial, auxiliary.

Latin→French.—abutment, account, acetic, acid, adhere, aileron, alley, alloy, angle, apartment, appliance, apron, aqueduct, arc, architrave, artisan, assemble, avalanche, avenue, balance, bottle, bushel, cable, caldron, calorie, canal.

Latin→Italian.—bronze, cupola, granite, lagoon, lava, malaria, pedestal, portico, scarify, terra cotta, volcano.

Latin→Spanish.—cork, corral, embargo.

French.—alette, artillery, attachment, avoirdupois, baffle, battery, bevel, blanket, blue, briquet, brush, bullet, butte, buttress, cabinet, caisson, chassis, chisel, chute, conduit, corduroy, correspond, crevasse, crush, debris, discharge, embrasure, enamel, entrance, entresol, escapement, foundry, franchise, gallery, garage, hangar, maintenance.

Italian.—balcony (Teutonic), balloon, bulletin, dado, fresco (Teutonic), gondola, quotation.

Spanish.—*adobe* (Egypt), bracket, cañon, capsize, cargo, manila, placer, platinum, pueblo (Greek), pump.

Portuguese.—tank.

Hybrid forms (Derive from two languages).—acetylene, aeroplane, alundum, ambergris, ammeter, apprenticeship, automobile, bankrupt, centimeter, dictaphone, embankment, galvanometer, guncotton, gunnysack, linseed, megohm, microfarad, monorail, nitrogen, oscillograph, passageway, petrify, potash, shellac, spiegeleisen, storehouse, tramway, tungoil, undervalue, vaseline, watthour.

Among the miscellaneous sources of the technical vocabulary we may count non-European countries, proper names, initiative forms, and recent coinages. These heads are represented by such words as:

NON-EUROPEAN LANGUAGES

Arabic.—alcohol, alkali, amber, benzoin, caliber, cotton, alembic, algebra, alidade, average, azimuth, caliper, chemistry, cipher, magazine, zenith, zero.

Persian.—borax, check, checker, pagoda, zirconium.

Indian.—bungalow, calico, coolie, corundum, dinghy, gunny, indigo, jungle, jute, khaki, lacquer, sugar, teak, tourmalin.

Malay.—atoll, bamboo, camphor, catamaran, gong, gutta percha, rattan, veranda.

China.—tung (oil).

America.—bayou, caoutchouc, canoe, catalpa, hammock, hickory, hurricane, mahogany, pung, tamarack, toboggan.

PROPER NAMES

Mythology and religion.—ammonia, cobalt, criss cross, cyclopean, herculean, hygiene, jovite, mercury, Mazda, mosaic, nickel, obsidian, ocean, phosphorus, protein, silenium, siren, tantalium, titanium, uranium, vanadium, volcano, vulcanize, amazon-stone, Goliath crane.

People.—ampere, bessemer, burnettize, byerlyte, coulomb, derrick, dolomite, farad, fahrenheit, galvanism, gauss, gilbert, gilsonite, gin, hefner, henry, jack, jenny, joule, lewis, macadam, marconigraph, maxwell, oersted, ohm, oliver, orrery, pasteurize, peavey, pinchbeck,

pullman, samarskite, sandwich, sherardize, shimose, shrapnel, silhouette, vernier, volt, watt, welsbach.

Places.—alabaster, arabesque, artesian, attic, bronze, calico, cambric, chestnut, coach, copper, damascene, frieze, gause, illinium, indigo, italics, japan, leyden, limousine, lumber, lyddite, magnet, manganese, meander, morocco, muslin, pistol, puzzolan, portland cement, ruthenium, sedan, silk, steelyard, sterling, spruce, surrey, Troy weight, turquoise.

Imitative forms.—boom, bubble, buzz, choke, cock, creak, crash, fizz, hiss, jerk, jiggle, jingle, knock, log, puff, rattle, ring, sizzle, splash, thud, tinkle, whistle, whizz.

Recent coinages.—bakelite, cantilever, carburetor, cosine, cordite, kodak, fluxolite, focus, galalith, gas, gyroscope, linoleum, locomotive, x-ray.

Diminutive forms.—alette, ashlar, formula, hatchet, hillock, mantissa, poppet, nozzle, nubbin.

Abbreviated forms.—fence, abscissa, mend, mile, pound, rent, size, street.

Tautological forms.—lukewarm, sledgehammer.

Mistaken forms.—pickax, squeegee, quagmire.

Forms from letters.—an ell, a wye.

Forms of obscure derivation.—awning, basket, bluff, burlap, chunk, clutch, cog, cotter, culvert, dory, flush, garbage, gasket, gumbo, gun, hitch, nipple, ogee, pack, patch, puddle, pulley, scoop, skin, slot, slug, spandrel, splash, spline, sprag, sprocket, squilgee, surf, winze.

Often again we find a common source will give derivatives of various meanings: For example:

Latin *uncialis* > inch, ounce, uncial.
Greek *diskos* > dais, dish, disk, desk, discus.
Dutch *jolle* > jolly boat, yawl.
Latin *canna* > canna, canon, cañon, cannon, channel, kennel, canal.
Latin *gradus* > grade, gradient, gradometer, gradual, graduate, graduation, gradation, degradation, degree, congres.
Greek *thursos* > torso, truss, trousers, trousseau.

Many forms are far-fetched, having come into English through a succession of sources. For example, the English word slate:

Low German, *klappen,* to *clap;* Late Latin, *ex-clapitare,* to break with a noise; Old French, *esclater,* to shiver, also *exclat,* a shivered piece; Middle English *s(c)lat;* Modern English, *slate, slat,* etc.

also *buoy:*

Greek, *bous,* ox; Latin, *bos,* ox; *boia,* a collar of oxhide; Old Italian, *boja,* a fetter; Old French, *boye,* a fettered mark; Old Dutch and Scandinavian, *boeye, boei,* etc.; Middle Dutch, *boeye;* Modern Dutch, *boei;* English, *buoy.*

Commonly derived forms are found in the case of many languages, to take as an example this same word buoy.

French, *bouée;* Spanish, *boya,* Portuguese, *bóia;* Italian, *boje;* German, *Boje;* Dutch, *boei;* Danish-Norwegian, *Boje;* Swedish, *boj;* Russian, *bui.*

These last cognates were taken from Charles B. Waite's *Homophonic Vocabulary* (A. C. McClurg & Co., Chicago, 1904), in which are given "more than two thousand words having a like sound and like signification in ten languages."

Words of common derivation are to be distinguished from cognate words belonging to different languages of the same family; as, for example: English, *house;* German, *haus;* Dutch, *huis;* Swedish, *hus,* Danish, *huus.*

Exercise.—Look up the derivation of the following words:

aerial, analysis, anthracite, arithmetic, asbestos, asphalt, atom, bacterium, barometer, bromine, cathode, period, creosote, crystal, diameter, diaphragm, dynamite, eccentric, electric, geometry, horizon, hydrogen, iodine, kilo-, microtome, oxide, periscope, pyrometer, symmetry, telegraph, topography, trigonometry, zodiac.

antenna, aqueduct, cement, centigrade, crucible, cupola, filter, gelatine, incandescent, insulate, journal, linoleum, malleable, manufacture, map, meridian, mile, mucilage, pencil, pendulum, petroleum, pilaster, scrupulous, shingle, stipulation, tangent, trammel, traction, torpedo, turbine, vehicle.

anvil, barn, book, brimstone, bucket, bunker, charcoal, clapboards, coke, crane, fretwork, oakum, pig iron, tarpaulin, tramway, trolley, walnut, windlass, window, caterpillar, easel, geyser, spruce, tungsten.

CHAPTER XXV

SPECIFICATION WRITING

- The nature of specifications.
  - Part of a composite document.
    - Plans.
    - Specifications.
    - Covenants.
  - Prerequisites of their composition.
    - A knowledge of the thing to be done.
    - An understanding of the personal factors involved.
    - A command of their conventional literary form.

- The writing of specifications.
  - Their essential qualities.
    - The matter of content.
      - Completeness.
      - Correctness.
      - Consistency.
    - The matter of style.
      - Clearness.
      - Coherence.
      - Conciseness.
      - Conventionality.
  - Their form and arrangement.
    - The matter of identification.
      - Of people.
      - Of materials.
    - The matter of phraseology.
      - Usage as regards.
        - Course of performance.
        - Strictness of performance.
      - Usage as regards.
        - Specific clauses.
        - General clauses.

- The technique of specification writing.
  - Its exacting character.
  - The importance of its mastery.

Engineering specifications are particularized documents setting forth the requirements and the acceptable limits of matter covered by a contract, and governing the relations and the several responsibilities of the parties to the same. They aim to insure the satisfactoriness of workmanship and of materials; to secure the efficient, economical, and expeditious prosecution of a piece of work; and in general to guide and inform the seller; and to safeguard the buyer, against any oversight, incompetency, or unscrupulousness in the execution of a contract.

Although specifications are common to all the branches of engineering—mechanical, electrical, and chemical, mining, hydraulic, and agricultural, naval, architectural, and the rest—each of these callings tends to utilize a certain restricted and specialized form. A highly generalized and comprehensive type is that which covers the projects of the civil engineer; so, to these we shall in this chapter confine our attention. A full set of such specifications will illustrate every principle in common use. The subject matter will in the main fall under such headings as excavation and construction, materials and appliances, labor and workmanship, supervision and responsibility, progress of the work, and payments for the same.

At the start the important question arises as to the limits of specifications, considering them in their strictest interpretation. Engineering undertakings are complicated in the extreme. Many elements are involved—matters not only scientific and technical, but practical as well; the specifications are the meeting ground, again, of engineering with commerce and law. In structure they are complex, including, for example, "advertisements to contractors," "proposals," "information to bidders," "contracts or covenants," and "bonds" whereby the party to whom the work is awarded guarantees the satisfactory fulfillment of his or their agreement. Strictly speaking, all of the forementioned papers are embraced by and come within the scope of the term "contract" when this is taken in its larger and more general sense. In fact an exhaustive study of either covenants or specifications would lead in the end to a consideration of all the forms; but in a study of the subject where the primary

interest is chiefly rhetorical, it seems wise to restrict the discussion to that tripartite document comprising the "specifications," the "plans," and the "contract." These three deal with the immediate and specific performance of the work. To such an extent are they cooperative, mutually explanatory, and so inextricably connected with one another that experience has shown they should be actually bound together through physical incorporation into a single book of reference. Our first endeavor must be to distinguish them as clearly as is possible, in the absence of definite and established lines of demarcation.

First in the logical sequence comes the picturing of the project found in the *Plans*. These plans, including the main drawings together with any sketches that may supplement them, should represent accurately and graphically all the details of design, noting particularly all such matters as position, form, scale, dimensions, and the like. They are prepared by the engineer and given to the successful contractor as his primary guide in the performance of his undertaking.

Next in order come the *Specifications*, which are written descriptions, prescribing the requirements of the work. In them the engineer supplements his plans by putting down such stipulations as he cannot graphically portray. Here, as has been intimated, belong the fuller treatment of features not adequately covered by the plans, the engineer's ideas relative to the sufficiency of materials and workmanship, and whatever else may pertain to the progress and specific performance of the business contemplated in the contract. Specifications are the better for being based upon plans as complete as possible. Advisable always are references to the plans in that part of the specifications which is devoted to whatever they portray. Upon the plans and specifications together the contractor depends for his directions; and only upon them can the owner, once they have been put in force base a claim for specific performance.

We now reach the *Contract*, Covenant, or Articles of Agreement, as the third and legalizing part of our document is variously called. As the names indicate, this is the record of a mutual understanding arrived at by competent parties,

whereby they consent to some exchange of goods or services, each binding himself to discharge certain specified obligations in return for a legal equivalent. Regularly such an agreement is reduced to writing (duplicates being made to the number of the contracting parties), duly signed, and witnessed.

Tucker defines a contract as "an agreement between competent parties, enforceable at law, whereby each acquires a right to what is promised by the other." [1]

Although very simple in its underlying idea, the contract is subject to surprising variations in the practice of different engineers. By one, it is reduced to the simplest statement that for a certain consideration one party agrees to carry out the work described in the plans and specifications in the manner there indicated; [2] whereas another person favors extending the contract, and elaborating it with many verbose phrases. Usually the drawing up of a contract involving large considerations is intrusted to legal counsel. Despite the lack of unanimity on the point of phraseology, that attitude is gaining favor which advocates simplicity of language, and the inclusion of doubtful clauses in the body of the specifications, which with the plans attached are incorporated with it by reference. Such a course, without sacrificing legality, obviates the liability of any unnecessary duplication and relegates the questionable clauses to the body of material with which they are most closely related, and to that context in which they are least likely to be misunderstood. So Ashbridge recommends keeping the general clauses "almost entirely in the specifications, making the contract as short and concise as possible." [3]

In case of conflict between these parts they take precedence in the order of inclusion, the greater outranking the lesser. On this point Johnson says: "As a rule the specifications control, rather than the plans, and the figures on

[1] Tucker, J. I., *Contracts in Engineering.* McGraw-Hill Book Co., Inc., New York, 1910. § 317.

[2] See Tucker, *op. cit.,* Chap. IX. Allen, C. F., *Business Law for Engineers.* McGraw-Hill Book Co., Inc., New York, 1919. Chap. XVI.

[3] Ashbridge, R. I. D., *Civil Engineering Specifications and Contracts.* Am. Tech. Soc., Chicago, 1914. P. 9.

the plans control, rather than the actual dimensions of the drawings when taken to scale." [4]

Prerequisites of Specifications Composition

To the writing of adequate specifications belong a number of obvious prerequisites. We shall consider certain of them under three large heads; namely, the Engineer and his Project, the Engineer and his People, and the Engineer as a writer of English.

In order to draw up a set of specifications delicate enough and flexible enough to meet every contingency, and strong enough to stand rough usage and all the pressure put upon them by financial interest, not to speak of the possible strain of legal procedure, an engineer must come to his work well equipped. Besides the thorough technical training which we must presuppose as a *sine qua non* of success, he must be possessed of a good general knowledge. This should include an acquaintance with business methods, and with the general procedure of the money market, a practical knowledge of commercial law, and an exact knowledge of the law of contracts. He should be well posted on labor conditions, and he should know well the genus "client," and the genus "contractor." With industrial affairs he should likewise be familiar, more especially with such matters as processes of manufacture, shop practice, staple commodities, the stock sizes of materials, and the relative cost and value of different brands. Experience, of course, is in all of these matters invaluable; but experience is by no means dependent upon age alone; "Though young in years one may be old in hours if one has wasted no time."

But as he draws closer to the work at hand, merely general knowledge will no longer suffice. Supplementing it should come information up-to-date and pertinent, based upon conditions at the place where the specifications are to be put in force. Accordingly, the engineer should take pains to familiarize himself in advance as fully and as accurately as possible on all the points which are in any way likely to

[4] Johnson, J. B., *Engineering Contracts and Specifications.* Engineering News Pub. Co., New York (McGraw-Hill Book Co.), 1895. P. 118.

influence success. What specific conditions, if any, are likely to affect his enterprise? what peculiarities in state or municipal labor laws, or in local usages as regards hours of work or terms of remuneration? Let him consider the character of the contractors who are likely to bid for the work; and, finally, let him not overlook local facilities for the provision and transportation of material, also the availability of different sorts of material and their relative advantages for the work he has to do. Ounces of such foresight may obviate pounds of subsequent worry and expense.

Needless, however, to dwell longer upon the fact that the engineer, before writing his specifications or drawing up his plans should have a clear and comprehensive idea of the entire project. Of primary importance is a thorough realization of the end desired, and of the purpose which his construction is intended to serve. Ruskin says in this connection, "I believe that failure is less frequently attributable to inefficiency of means or impatience of labor, than to a confused understanding of the thing actually to be done." [5] This purpose will often determine whether an old design will serve, or whether some new plan, either in whole or in part, will best meet the requirements. Having this end in mind, and having made his preliminary estimates and investigations, he is first in a position to consider alternatives of design, their peculiar applicability, or possible objectionable features. Next, having determined upon his plan, he must visualize the entire program of its construction, bearing in mind step by step the best and most recent practice of the profession, and giving due weight to the experiences of other engineers on similar enterprises. No plans should be laid without attention to the rate of progress, and to the proper coordination and articulation of the several parts of the work; or without allowing sufficient flexibility to provide for possible and desirable alterations. When complete, this program of procedure will be subjected to a searching inspection, as to its practicability and sufficiency both as a whole and in its details, attention being directed from every point of view to such matters as strength, durability, economy, and appearance. To knowledge and resolution, he

[5] Introduction to *The Seven Lamps of Architecture.*

must add imagination; and to this he must add again that faith in things not seen, that is born, not of fond hopes, but of indefatigable attention to details.

An Understanding of the Personal Factors Involved

The engineer who administers the erection of any important structure finds his task complicated by the presence of uncertain personal equations, by the entrance of human factors of unknown character. He manages not machines only but men—and men of many stations and capacities. If he is to succeed he must impress them with a sense of his executive ability, of his judgment, sagacity, and fair-mindedness, and last of all, let us say, of his firmness. The engineer's ultimate success will depend upon the satisfactory outcome of many an enterprise, upon a reputation built up only by slow degrees. In the first place, it will depend upon known loyalty to his employers, and upon a recognized ability to produce for these clients certain definite results. But to accomplish such ends without the good will and cooperation of the men who actually do the work is well nigh impossible. He must, by his attitude, inspire these men to harmonious action; he must impress them as one who is impartial and fair-minded. To achieve this end, his thought and expression must be clear and definitive. In such details as the apportioning of responsibility and the defining of extra work he should spare no pains to avoid ambiguity in his phraseology. He does well to remember that "the reputation for honesty is the best asset of the engineering profession." Exact he must be, without being unduly stringent; he must take for granted the performance of no single essential thing. And with this quality of strictness should go self-confidence and assurance—traits these which universally inspire confidence and promote respect. Possessed of these qualities, he will come to be known as one who seeks no more than an honest equivalent, and as one who countenances nothing less; as one who describes any work fairly and squarely, and one who demands in its execution no more than the fulfilling of his obvious prescription. In short, such

a man is a known quantity—a man in whose professional charge clients are glad to repose their interests, confident that upon his specifications contractors can afford to place their closest bids; confident again that under his direction work will be carried on with all possible economy and dispatch.

A Command of Conventional Literary Form

Now such a reputation is in large measure bound up with the character of the specifications which an engineer habitually puts himself under the necessity of enforcing. Where he seldom is called upon to argue over an interpretation of his specifications, to play the autocrat in their enforcement, or perforce to alter their original content, he establishes thereby a reputation for competence which will prove a valuable asset to himself, and which will go far toward maintaining the fine traditions of his profession.

R. S. Kirby insists that "Nowhere is the ability to express his thoughts in clear and forcible English more necessary to an engineer than in the preparation of his specifications." [6] Now while every authority has insisted on the importance of form in the writing of contracts and specifications, most writers on the subject have confined themselves to the technical, business, and legal aspects to the neglecting of the rhetorical. Yet this last element, which is concerned with the manner rather than the matter, with the form as distinguished from the facts to be presented, is undoubtedly of sufficient importance to warrant not a little attention for its own sake; for we cannot expect literary efficiency to come without due training, any more than we can presume that technical equipment will be furnished solely by our mother wit.

The Writing of Specifications

When we consider the requisites for the writing of good specifications, we are met at the start by three qualities which apply both to the content and to the style, namely, *com-*

[6] *The Elements of Specification Writing.* John Wiley & Sons, Inc., New York, 1913. P. 31.

pleteness, correctness, and *consistency.* Every item of information or of stipulation should be sufficient, trustworthy, and in harmony with every other. When these qualities are assured, the economizing of the reader's attention may be further effected by giving heed to such other stylistic qualities as *clearness, coherence, conciseness,* and *conventionality.* These four contribute materially to the ease and certainty of interpretation, insure the logical unfolding of the subject, guard against the use of unnecessary words, and finally present the meaning in familiar and accustomed guise.

Completeness in specifications as in all other human affairs is a relative term. Treatment may be full and adequate without being absolutely exhaustive. The ideal should be such uniform thoroughness as shall admit of no "scamping" of the work, or of any departure from the scale originally adopted as sufficient. No essential feature should be either neglected or taken for granted; no intermediate step, no last detail, should be left to the contractor's voluntary performance as a matter of course. No blanket clause should be depended upon to protect the engineer from the consequences of his own slackness. The constant ratio between completeness and cost should never be overlooked. The nearer, of course, that the treatment approaches to exhaustiveness, the closer will be the approximation between the price paid and the value received. The greater the degree of uncertainty, on the other hand, the more ample must be the provision made by the contractor against the same. Therefore, since economy is a chief test of engineering efficiency, no effort should be spared in bringing all parties to a definite understanding of the exact nature of the thing contracted for. The writer of specifications should check over such similar documents as are available; and may even find it to his advantage to refer to extensive tabulations of general and specific clauses for possible suggestion as to details which might otherwise be overlooked. Among items most liable to escape attention are notations of dimensions and values, definitions of quality, clauses bearing on the limits of the work, references to inclusions, and cross references to plans, tables, drawings, and the like. Some such omission is all too likely to appear despite the most pains-

taking care; the most that can be done is to reduce the number to a minimum. But where the arrangement is clear and logical, mere extensiveness is not likely to detract either from ease of reference or from general intelligibility. Here, however, sound judgment should go hand in hand with that eternal vigilance which ought to be a chief mark whereby to know an engineer. Possessed of these he can present the facts, all the facts, and nothing but the facts.

But completeness should no more mark the content of the specifications than it should the shape in which they are cast. In this connection, one should ever guard against abbreviated forms which might lead to ambiguity. Again, one should exercise care not to impair the meaning of one's sentence by the omission of any conjunctive adverb, preposition, or other introductory word, especially in a series; or by the leaving out of such verbal auxiliaries as relate successive predicates to a common subject; or by neglecting such pronouns as may prove necessary to make the reference indubitable. Wherever repetition will bring out the intention, repetition should be freely used, and this despite any resultant awkwardness in the movement of the sentence. Once more, a liberal use of synonyms is not infrequently a means of ensuring a more thorough covering of a somewhat complicated or doubtful situation. Finally, it may well be remembered that punctuation plays an important part in determining the meaning of a sentence once this sentence has become involved. Consequently, punctuation ought not to be overlooked; but in general one should not rest satisfied with any expression whose interpretation hangs upon the placing of a comma.

Correctness is concerned less with the sins of omission than it is with those of commission. Upon the writer of specifications rests eternally the burden of accuracy. Failure to fit the expression to the thought may make him responsible for what was never in his mind. Exact must be the correspondence between the common acceptation of the symbols he uses and the facts he would present. This necessitates that his thinking be sharply defined, and that constant and scrupulous attention be given to his every word. Every definition must be explicit, and every reference to personal

identity; and every statement involving quantity or quality, inclusions or exclusions, distinctions and limitations, must be specific and precise. "It will not do," Waddell reminds us, "for him [the engineer] to say 'about this' or 'about that,' for the 'about' is very liable to assume proportions which were never dreamed of when the term was used."[7] More particularly all statements involving units of measure, acceptable maxima or minima, allowances and tolerations, terms of payment, extra work, and the like, should be subjected to rigid inspection from different points of view. The writer of specifications does well to remember that an ill-considered copying of clauses has given rise to many a predicament.

Rhetorically, correctness demands that all spellings, abbreviations, and punctuation conform to good usage, that words be used in their proper sense, and that inflection and syntax be free from solecism or impropriety. Self-misrepresentation will be forestalled only by firmly resolving to mean what one says and to say what one means.

Consistency, or the harmonious correlation of the component parts of the contract is at once a great virtue and a constant source of difficulty. Conflict between the parts may occur where measurements are in one place designated literally and in another relatively; or where responsibility for some particular work is in different places variously assigned. Any incompatibility, not to say flat contradiction, invariably gives rise to perplexity and argument; and may, indeed, lead to irreconcilable disagreement; which in the end may necessitate an arbitrary ruling of the engineer, or even recourse to the law with its consequent delay, expense, and mutual bitterness.

To avoid inconsistency, one should bear in mind from the start that the contract is an organic thing. Each of its separate parts has its own peculiar function. In it is a place for everything, and in it everything should appear in its own

[7] Waddell, J. A. L., "Specifications in General," *Bridge Engineering.* John Wiley & Sons, Inc., New York, 1916. Vol. II, chap. LXVIII, p. 1555. See chap. LXIX, "Contracts." See also the same author's *Engineering Specifications and Contracts* (with notes on the law of contracts by John C. Wait). The Engineering News Publishing Company (McGraw-Hill Book Co.), New York, 1908.

appointed place. Where this complementary feature is regarded, the number of duplications in specifications and covenants, or in general and specific clauses, or in specifications and drawings, will be diminished, to the avoiding of much confusion. Another source of discord is found in the practice of copying clauses from different sets of specifications. Still another lies in the practice of drawing up the parts of the contract with too little attention to their complementary character. This is particularly the case where the composition of the several papers is left to different people; or where it is undertaken before the actual plan of procedure has reached a stage sufficiently advanced. Again discrepancies are apt to creep in through the making of alterations in one paper only; and through a failure to verify the harmony of the several documents in detail before finally they have been accepted as complete.

Consistency will be increased by keeping the plan well in mind. Whatever is possible should be done to bind together the entire contract; as for example, by a comprehensive system of symbols with frequent cross reference. One should bear in mind the value of a single style of writing, of a single scale of minuteness in one's every stipulation, and of completeness together with exclusiveness in the matter of every clause. Attention to the foregoing points will much lessen the danger of saying one thing in one place and elsewhere something else.

The Matter of Style

Clearness stands first among the more peculiarly rhetorical qualities of this sort of writing. Our production must be more than comprehensive, it must also be comprehensible; accuracy and consistency mean little to us apart from intelligibility. This quality of clearness, indeed, is indispensable to any good technical style. Plainness and straightforwardness are both virtues; baldness of style is infinitely preferable to obscurity. Directness of statement is the greatest oxidizer of ambiguity; and therefore it becomes the greatest single factor in making what we write fool-proof and scamp-proof. "Clear enough for all intents and purposes," as the saying

is, will never do. Our words should in their meaning be so unmistakable that to assign to them more than one interpretation would appear on the face of it absurd. Pellucid and perspicuous, they must admit of no misapprehensions—no shadows of doubt, no vague half-lights.

The value of this quality is at once apparent; uncertainty of expression means certainty of expense. Lucidity is economy; laxity is extravagance. Notorious, however, is the absence of this quality. An old joke has it that specifications are instruments written as guessing games for contractors and as grist for the mills of law. The writer should assure himself that his words are susceptible of but one interpretation; and that this meaning is so obvious that he who runs may read. This is the problem of clearness. According to Waddell, "Strict or even unjust clauses are by no means as detrimental to either party as those which are ambiguous." [8]

A sharp visualizing of the matter under consideration makes as nothing else for clearness; important also is the selection of words, and the careful scrutinizing of all parallelism. Close attention should be given such matters as the grammatical antecedents of any pronouns, the reference of participles, and the position of modifiers. Involved and complicated forms should always be avoided. Sentences should be regular; clauses, brief and to the point; sections, highly unified and mutually exclusive; the entire plan, in short, checked and rechecked against dubiety. By such means as these specifications may be clarified. Other qualities of style, such as force, beauty, and appropriateness, will make their appearance just in proportion as the signification is crystal clear.

Coherence, among the rhetorical qualities, is the chief supporter of clearness. All material must be correlated, systematized, reduced to order; next, it must be bound together in this approved sequence; and finally, all relationships must be made obvious to the reader. Coherence necessitates classification and organization; the coordinating and

[8] Waddell, J. A. L., "Specifications." *The Principal Professional Papers.* Edited by John Lyle Harrington. Virgil H. Hewes, New York, 1905. P. 912. Cf.—"Ambiguous clauses are the most detrimental of all." P. 870.

subordinating of each and every constituent part, and the explicit marking of like matter according to some method deemed most convenient. Only as this process is carried out can a "set" of specifications be said to be "composed." Where it is lacking, our clauses comprise only a miscellaneous collection. The greater the magnitude of an enterprise, the greater the necessity for coherence. The particular form of arrangement will depend entirely upon the nature of the work. Many methods of procedure might be mentioned which would alike be logical. One may, for example, go from general description to details; again one may go from simplicity to complexity; or one may follow the arrangement of parts, or the steps in manufacture, in transportation, or in construction. The groupings of related matter unquestionably become more apparent if attention is given to such devices as parallelism in grammatical structure, and to the use of similar introductory words in such parts as are coordinate.

The number of subdivisions should be limited as much as the nature of the case permits. Aristotle's favorite twofold grouping may be recommended as the most effective. The dichotomy, or dual division, is simple,—also, it is natural. No long succession of variously related and unrelated headings should ever be tolerated. One of the chief ends served by the standardization of specifications has been the doing away with this unorganized sort, and the introducing of a type wherein the reader progresses regularly through a series of related groups of facts which never conflict, and which in their entirety exhaust the subject.

Some comprehensive system of reference is altogether desirable. The pages of the document should be numbered in arabic figures in the upper right-hand corner. Each of the contract documents may be designated by a capital letter; each table by a roman numeral, and each drawing, diagram, or figure, by an arabic figure. Each principal division, or "Part," in the body of the specifications will have its subtitle centered on the page, and preceded by a roman numeral. Each main division, or "Section," of these parts will have its own marginal heading, preceded by an arabic figure; and will have its own divisions, the "subsections," or "clauses"

marked by lower-case letters. Numerals and figures may run consecutively throughout the document; letters, through one section only.

Conciseness refers to that restraint which keeps completeness within due bounds. It might have been included under clearness as one of its chief determining factors; yet its importance and distinctiveness seem to warrant a separate consideration. Our day agrees with Polonius that the soul of wisdom lies in brevity. "Brevity when consistent with completeness, is the hall-mark of a good specification." [9] "Words, words, words" have no place in compositions of this order. Has the engineer the ability to make one dollar do the work of two? Then let him strive for a like ability in respect to his words. Let him renounce all verbiage, all meaningless qualifiers and superfluous clauses, and reduce each time-honored locution to the clear-cut expression of a business document. A terse, crisp style affords few lurking places for inaccuracies and ambiguities. Its pithy, pointed character is fatal to the loose and dubious. Such a style need borrow nothing from either literary grace or legal garbling.

Conventionality, the last of our qualities, has its main reference to observance of precedent—to conformity to such usages as have become established in professional practice. Conventionality contributes both to clearness and to economy of presentation. The mind works more swiftly and effectively along paths to which it is accustomed. The vogue of a convention is likely to rest upon intrinsic worth, for the course of evolution is forever eliminating the unfit, and establishing forms which in practice have demonstrated their adequacy. Whatever has been repeated with uniform success is likely to be in accord with fundamental law. That which has proved itself under conditions of actuality, has earned precedence over the untried. In the long run, beyond a doubt, its adoption will be justified.

The engineer should, accordingly, collect the standard forms in his own field, and annotate them with comments bearing on their effectiveness in actual practice. By such a collection and criticism of clauses, he will gradually assemble

[9] Tucker, J. I., *op. cit.* P. 459.

a set both sound and flexible; he will eradicate imperfect elements, discover where emphasis best belongs, and incidentally develop a habit of mind which will be well worth all the pains involved. The value of such a selection of clauses, arranged and tabulated for ease of reference, and adjustable to different conditions, can scarcely be over-estimated. The habit thus developed of weighing the relative merits of verbal formulas is a necessary corrective of the practice of collecting and of adopting type forms. While an arbitrary departure from approved usage has no virtue whatsoever, the fact should be borne in mind that every engineering operation involves new problems. Possibly in its larger aspects, most certainly in its details, any efficient and economical prosecution will call for deviation from customary practice. Not infrequently, also, one change entails another, thus necessitating, first and last, somewhat extensive alterations. Moreover, one should remember that the standards of engineering are far from static; and that specifications that were designed to meet the conditions of yesterday are to an extent inadequate for the more exacting demands of today. In the light of all this, we see the futility of any blind and promiscuous copying,—even of clauses that have abundantly proved their effectiveness in the past. The cut-and-carry method of appropriating at large,—or as it has been termed, the "scissors and paste-pot" method, is far from satisfying the demands of this last quality of conventionality. In other words, conformity to usage must be critical and must be intelligent. Naturally, the wider the experience, the safer the deviation from standard practice.

The Form and Arrangement of Specifications

Identification

The multitudinous projects of our day have made indexing and tabulation not only a convenience but a matter of necessity. The advantage of easy identification and reference must not be overlooked by the writer of specifications, either as regards the entire article, or as regards its constituent parts. Each of these must be fitted with some dis-

tinctive and authoritative means of recognition. The time and place of drawing up the document may well be entered at the start. Next a title should be furnished indicative of the matter included by the contract. This title should be sufficiently distinctive to provide against confusion with other documents. It may moreover be advisable, for example, in the case of extensive enterprises, to supplement the main title with a subtitle enlarging upon it, and even to expand this one in turn to a short paragraph which shall set forth the main features of the subject under consideration. Likewise, each component part will receive its own distinctive title; and will be enumerated in the contract as mutually explanatory and equally authoritative. Here may be included, together with the agreement or covenant, the detail specifications, the plan, the supplementary drawings and tables, the advertisement, the directions for bidders, the proposal, and the surety bond given by the contractor,—each and all properly designated. Note should be made of the number of copies available, of whether they are furnished in duplicate, in triplicate, or in larger numbers, and of their distinctive markings—and of the time, place, and manner of securing and of surrendering them.

As the work of identification is carried on, each new division will be given its subhead, either centered on the page or beginning a paragraph, according to its importance; and each new section will be indicated by a marginal heading, indicative of its content. Different type will show the coordination and subordination of these several divisions: the main title being indicated by triple underscoring for large, or "full" capitals, the subtitles by double lines for small capitals; and the headings of succeeding grades by single lines for italics, or by wavy lines for black-face type, black-face type being more particularly used for marginal headings.

Of special importance is the indicating of the identity of the parties to the contract. The number of these may generally be reduced to two; although either of these, the party of the first part—he who buys and pays for the work (by which term is understood both labor and materials), or the party of the second part—he who furnishes the same, may

be composite. In the first case, we may have, for example, a state or municipality, a corporation, a firm, or an individual; in the second, one or more contractors and subcontractors operating in various relations. Each of these parties to the contract, together with any person or persons upon whom their responsibility or authority may fall, whether board, partner, or official, should be definitely pointed out. To this end the writer of specifications does well at the start to indicate any terms that may be used to referring to such principals or agents. Thus in large projects, the term "engineer" should be so qualified as to make clear whether the person intended is the consulting engineer, the resident engineer, or possibly some other. So, too, the proper designation of any co-contractors or sub-contractors becomes, obviously, a matter of importance.

Another phase of identification concerns itself with materials. All terms in this department call properly for definition, either in a blanket paragraph at the start, or at the point where they first occur. All symbols and abbreviations referring to such materials, should be handled with extreme care, to the end that all such references may be entirely unequivocal.

Division

All "clauses," by which we understand the brief paragraphs dealing with single stipulations, should be gathered under one or the other of two headings, general and specific. General clauses embrace all those whose application is to the work as a whole, and are to a large extent those of administrative, business, or legal aspect; whereas specific clauses deal with technique, with materials, and with the manner of execution—state that such and such things *"shall"* be done. Whereas the former are concerned with the relations of the parties and with the manner of payment, the latter have to do more particularly with design and construction. The affinity of the former is with the covenants, or agreement; that of the latter with the plans, or detail drawings.

The Matter of Phraseology

Other points to be considered which can be noted here only in outline but which should be studied in details of phraseology as these appear in standard specifications are the following:

Strictness in prescription:
- Variations—tolerances,
  - Determined by the engineer:
    - Mandatory injunctions—rigid requirements.
    - Discretional alterations.
    - Injunctions to extra care or to effect particular results.
    - Recommendation—preference.
    - General prescription.
  - Determined by the contractor:
    - Allowed exceptions to rule.
    - Allowed limits of variation.
    - Permitted alternative, or option.
    - Maximum or minimum limits.
    - Reasonable approximation.
  - Determined by the conditions:
    - By possibility of accomplishment.
    - By practicability of accomplishment.
    - By necessity of accomplishment.
    - By suitability or sufficiency.
    - By developments.

Specific clauses:
- General description of the work.
- Time and rate of progress
  - Of commencement of work.
  - Of progress of work,
    - Continuous.
    - Simultaneous with other work.
    - Intermittent, in the intervals of other work.
  - Of suspension of work.
  - Of completion of work.
- Location of work:
  - Of beginning.
  - Of extended operations.
  - Of successive operations.
- Materials:
  - Provision of materials,
    - By whom furnished.

    - By whom transported and delivered.
    - By whom placed, set up, or assembled.
    - By whom protected, guaranteed, or insured.
  - Character of materials—how determined?
    - By identification of brand.
    - By general conformity to type, standard, or design.
    - By quality of manufacture,
      - Best selected.
      - Standard.
      - Good.
      - Subject to specified test.
    - By specified process of manufacture.
    - By qualitative composition—ingredients.
    - By quantitative composition—consistency, weight, or bulk.
    - Character to vary on different parts of the work.
    - Finish, etc.
  - Method of placing materials:
    - Means of depositing, applying, treating, etc.
    - Quantities to be used.
    - Acceptability of parts, etc.; discards, etc.
    - Definition of "extras."
  - Testing, examining, inspecting material:
    - Responsibility for tests,
      - Expense of tests.
      - Facilities for tests.
      - Satisfactoriness of tests.
      - Certification, and reports on tests.
    - Character of tests.
    - Time of making tests.
    - Place of making tests.
    - Number and frequency of tests.
    - Selection of test material.
    - Retests and reinspections.
    - Disposition of test material.
  - Rejection and replacement of material.

- Appliances and equipment:
  - Provision of appliances.
  - Efficiency of appliances.
  - Royalties on appliances.

- Labor:
  - Provision of labor.
  - Number of men employed.
  - Personnel of men employed,
    - Subject to approval.
    - Degree of skill or competency.
    - Special types of workmen—overseers, etc.

Recommendations as to citizenship, residence, etc.
Prohibitions and preferences of employment.
Control of men by the engineer.

Grade and quality of workmanship:
Standards to be applied.
Wages to be paid.
Extra work.
Defective workmanship.

Method of construction:
Shape, arrangement, dimensions, strength, finish.
Spacing, joining, loading, reinforcing, etc.
Special features.

Protection:
Painting, fireproofing, weather proofing, etc.
Cleaning up, etc.

General clauses:
Scope and intention of the specification.
Division of responsibility, obligation, or authority:
For the first party to the contract—the owner, municipality, etc.:
Commissioner.
Chief Engineer,
Sufficiency of the design.
Successful outcome of the undertaking.
Right to make minor alterations without cost, and larger changes at a cost to be appraised.
Sole referee and arbiter of disagreements.
Determines satisfactoriness of the work either finished or in progress.
Resident, construction, or supervising engineer,
Proper enforcement of the specifications.
Supervision of the inspectors.
Determination of measurements, estimates, extras, etc.
For the second party to the contract,—the contractor:
Fulfilling the provisions of the plans and specifications.
Checking of the plans and specifications.
Serving of notices, obtaining necessary permissions, etc.
Preparing the site of the work.
Properly safeguarding the work, the workmen, and the public.
Assuming liability of injuries resulting from the work.
Keeping the work in proper repair until its acceptance.
Agreeing to carry on the work himself, save by the consent of the party of the first part.
Providing ways and means for accomplishing the work.
Giving proof that his accounts are duly paid.
Exempting the owner from liability.

Payments:
- **Character,**
  - **Lump sum.**
  - **Unit price.**
  - **Cost plus percentage.**
  - **Cost plus fixed sum.**
- **Remuneration for extras.**
- **Frequency and amount of payments.**
- **Final payment.**

The Technique of Specification Writing

Every point in the foregoing list has its own locutions, its own nouns and verbs, adjectives, and turns of phrase. None of these means the same as do the others. Especially in specification writing is it true that the language knows no synonyms. What one has written, moreover, one must abide by. As a result, the young engineer does well to make specification writing his special study—to collate specifications, to analyze them down to the least minutia of phraseology, at least for the first five years after his graduation. By that time, the importance—the significance—of this department of composition will have dawned on him; and by that time also, he will have realized the great value of this same exercise, for in just such fitting of words to realities lies the stern virtue of Engineering English. As aesthetics believes that the style—is the thought—is the man, so Engineering holds that words—should equal thoughts—should equal facts.

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